

Edited by
Konrad Raczkowski
Piotr Komorowski
Friedrich Schneider

Challenges *in the* Global Economy



"The only thing we have to fear is fear itself...
which paralyzes needed efforts to convert
retreat into advance."

– Franklin D. Roosevelt
Inaugural Address



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Introduction

The global economy of the 21st century stands at a crossroads, marked by an unprecedented confluence of crises, technological disruptions, and geopolitical tensions. This book, *Challenges in the Global Economy*, explores these dynamics through the lens of economic paradigms, blending classical economic theories with contemporary challenges. One particularly pressing concern is the impact of regional wars, whose ripple effects extend far beyond battlefields, reshaping global trade, financial stability, and international cooperation. In addition, populism and the complete abandonment by most governments of rational levels of public debt will have consequences in the future.

Economic science has long relied on models of equilibrium and predictable behaviour, yet the modern global economy is anything but stable. Real and forced wars, to which the international community responds with expulsions, the ideology of climate change, which distorts the pragmatism of economic turnover and competitiveness, especially in Europe, and technological revolutions disrupt established patterns, challenging the traditional assumptions of economic theory. This book seeks to navigate these complexities by examining how these evolving paradigms redefine our understanding of economic development, global trade, and resource allocation.

The book consists of seven chapters. In the first chapter entitled Polycrisis in the Global Economy and Economic Analysis delves into the interrelated crises or “polycrisis” that define today’s global economy, from financial instability and supply chain disruptions to environmental disasters and geopolitical conflicts. The chapter highlights how economic analysis must adapt to this complexity, taking into account simultaneous and interdependent challenges, while coinciding phenomena, as well as assigned meaning weights in econometric research that require double-checking.

Social Changes Caused by Fundamental Convergence in the Functioning of the World Economy is the subject of chapter two. The author examines how economic integration is shaping societies, affecting labour markets, income distribution and migration patterns. It assesses the social adjustments forced by the evolving global economic structure.

In the third chapter the author explores the technological divide, examining three fundamental models. It analyses the Frontier Technology Readiness Index and delves into specific aspects such as innovation, digital access, and high-tech manufacturing. By understanding these factors, we can better grasp the dynamics between advanced and emerging economies and the potential for narrowing or widening the technological gap.

Chapter four focuses on the critical role of energy in economic growth and global power dynamics. It examines the top 10 economies (representing 66.5% of global GDP) from 1990 to 2022, focusing on energy consumption, electricity, prices, innovation, and wealth. Despite extensive research, key energy challenges like pollution and price volatility remain unsolved.

In the fifth chapter, the author examines the growth of the investment fund industry. It reviews the key types of funds, including mutual funds and UCITS/AIFs, and discusses their role in diversifying risk and generating returns. The study analyses market trends and the development of new financial instruments, concluding that the market continues to grow rapidly.

The sixth chapter explains the impact of climate change on society and the economy, causing droughts, fires, floods, and rising temperatures. While the cause is debated, the effects are real. Green and circular economies are responses that promote sustainability through clean technologies and reduced waste.

The seventh chapter compares the monetary policies of the Federal Reserve (Fed) and the European Central Bank (ECB) focusing on their similarities and differences, but also examines the issue of synergy of the monetary policy applied by the National Bank of Poland. The pioneer in the application of specific anti-crisis active monetary policy intervention instruments used during recent financial and economic crises was most often the Federal Reserve Bank, while the European Central Bank as well as the National Bank of Poland in many respects imitated the Fed's earlier solutions.

By examining these interconnected themes, *Challenges in the Global Economy* provides a comprehensive analysis of the forces reshaping the world today. The book emphasizes the need for adaptive economic thinking that transcends

outdated models, urging economists, policymakers, and business leaders to reconsider how we address global challenges in a rapidly changing world.

As scientific editors, we wish you a successful reading, and to politicians and the business world a positive formation of the world economy, where the economic man will not become an object, and the factors of production will be protected by property rights and effectively implemented international law.

Konrad Raczkowski, Piotr Komorowski, Friedrich Schneider

Polycrisis in the global economy and economic analysis

Konrad Raczkowski
Piotr Komorowski
Friedrich Schneider

Introduction

The concept of polycrisis has emerged as a powerful analytical framework for the understanding of the complexities of the global economy in the 21st century. A polycrisis is characterised by the simultaneous occurrence of multiple interconnected crises that amplify one another's effects, resulting in systemic disruptions that are more severe than the sum of their parts. Unlike isolated economic shocks, polycrisis involves intricate feedback loops where economic, political, social, and environmental factors interrelate, creating a cascading impact across sectors and national boundaries. This chapter explores how economic theory has sought to grapple with this phenomenon, examining both the contributions and limitations of various schools of thought.

From an economic point of view, the achievements of the Keynesian school may be particularly relevant in the study of polycrisis, emphasising countercyclical fiscal policies and public sector intervention to stabilise economies – where simultaneous economic shocks can overwhelm private sector responses. It is also important to re-examine the neoliberal paradigm, which has rightly been criticised, in light of global polycrises, such as the 2008 financial crisis, the COVID-19 pandemic, and Russia's economically motivated conventional wars with Ukraine and in the Middle

East, which exposed the weaknesses of unregulated markets while demonstrating strong state interventionism. On the one hand, any deregulation can lead to exacerbating crises, while on the other hand, it can lead to greater economic freedom, achieving development and economic growth. Everything must be weighed against the skilful application (rather than ideological denial in its entirety) of this paradigm. Finally, turn to the paradigm of complexity economics, which offers a paradigm shift from traditional equilibrium models, emphasising the nature of the economy as a dynamic system characterised by non-linear interactions and feedback loops. This perspective inherently recognises the multifaceted nature of crises, which cannot be understood through linear cause-and-effect relationships. Complexity economics questions the predictive power of classical and neoclassical models, advocating an approach that recognises the economy as a system marked by emergent behaviour and adaptive agents, and this approach seems appropriate and pragmatic. The study of polycrises, therefore, challenges economists to rethink traditional models and adopt a multidisciplinary perspective that integrates insights from finance, management, sociology, or political science. At the same time, the ecological current in economics must be applied with caution and a rejection of pure ideology in favour of pragmatism and the adoption of a strategic approach.

In this chapter, we will delve into these paradigms, assessing their contribution to understanding the complexities of polycrises and identifying gaps where further research is needed. The stakes are high because the ability to anticipate and mitigate the cascading effects of global crises will shape the resilience and stability of economies in the coming decades; thus, the theory and ideology disconnected from reality and pragmatic effectiveness cannot be the determinant of socioeconomic changes.

For the purpose of this study, the Economic Policy Uncertainty Index (EPU) will be used, with values averaged over the period 2008–2023 (and 2000–2024) for five global economies, such as the United States, China, Japan, Germany, and the United Kingdom.

1.1. The essence of a polycrisis

With increasingly complex economic, technical, and social problems came the need to solve problems simultaneously, which is an interdisciplinary and system-based approach. The origins of multi-dimensional problem-solving can be traced back to the 1940s and 1950s. It started with linear programming and multiple criteria optimisation theory in the 1940s, with the development of trade-off and Pareto

optimality theory¹. At that time, significant contributions were also made in the field of operations research. Mathematical and statistical methods began to be applied to optimise military decisions. After the war, those methods were used to help solve economic and industrial problems. In particular, attention was paid to optimisation under conditions of limited resources, which often involved solving many complex problems simultaneously². In the 1950s, general systems theory was born and its founder, Ludwig von Bertalanffy, introduced a holistic approach to systems analysis whose aim was to integrate different scientific disciplines and enable problems to be solved holistically, and not just by examining individual elements³. The theories that significantly contributed to solving complex problems that often occur simultaneously include the non-linear theories initiated in the 1970s and 1980s, such as the catastrophe theory (René Thom)⁴ and the chaos theory (Edward Lorenz)⁵. These theories were used to model and analyse systems in which many phenomena are strongly interconnected and can lead to sudden changes in the state of the system.

Although economists often turned to systems analysis, the overly scientific approach made it difficult for politicians and the public to understand the terms and approaches. For example, relying on the term “crisis” and its synonyms is much easier than using the Chebyshev’s trade-off function or weighted objective function methods – the categories that few understand. This is how the term “polycrisis” emerged as an attempt to describe anew the complex and interconnected networks of challenges facing humanity. It is assumed that the terminology was introduced by Edgar Morin and Anne Brigitte Kern in their publication *Homeland earth, A Manifesto for the New Millennium*, published in 1999. In describing polycrisis, the authors note that it is “no single vital problem, but many vital problems, and it is this complex intersolidarity of problems, antagonisms, crises, uncontrolled processes, and the general crisis of the planet that constitutes the number one vital problem.”⁶

1 Figueira, J., Greco, S., & Ehrgott, M. (Eds.). (2005). *Multiple Criteria Decision Analysis: State of the Art Surveys*. Springer.

2 Hillier, F.S., & Lieberman, G.J. (1957). *Introduction to Operations Research*. New York: McGraw-Hill.

3 Bertalanffy, L. (1968). *General System Theory: Foundations, Development, Applications*. New York: George Braziller.

4 Thom, R. (1975). *Structural Stability and Morphogenesis*. W.A. Benjamin.

5 Lorenz, E.N. (1993). *The Essence of Chaos*. University of Washington Press.

6 E. Morin, A. B. Kern, *Homeland Earth: A Manifesto for the New Millenium*, Hompton Press, University of Michigan, Michigan 1999, p. 74.

Adam Tooze, a historian at Columbia University and editor-in-chief of the *Financial Times*, first introduced his readers to the term “polycrisis” in October 2022⁷. He argued that with climate change, the threat of nuclear war, pandemics, and global economic collapse, the world is now experiencing the most complex yet evolving combination of challenges in modern history. Due to these changes, all other visions of modernist socio-economic progress have to be set aside. Following the article that started the discussion, the *Financial Times* published further articles addressing economic policy⁸ (Wolf 2022) and stability and shocks⁹. As a result of the widespread discussion, “polycrisis” has become a fashionable and widely used term used by financiers, legislators, and policymakers looking for ways to find solutions for their areas in a drastically changing world, as evidenced by the ongoing discussions at the World Economic Forum in Davos in January 2023¹⁰.

Despite the relatively short history of the widespread use of the term “polycrisis”, it is capacious and has a longer history of use. This is because it defined what had existed for a long time but had not been named. The following table shows how the term “polycrisis” evolved to be incorporated into basic concepts applied in the scientific field and common usage¹¹:

TABLE 1. The genesis of the term “polycrisis” in various areas of application

AREA OF APPLICATION	GENESIS
Academic use	South African researcher Mark Swilling used the term in 2013 to capture the interconnectedness of social, economic, environmental, and institutional crises ¹² .

7 A. Tooze, *Welcome to the world of the polycrisis*, Financial Times, 28 October 2022.

8 M. Wolf, *How to think about policy in a polycrisis*, Financial Times, 29 November 2022.

9 G. Tett, *The great disruption has only just begun: History has shown that stability is, more often, the exception*, Financial Times, 14 December 2022.

10 *Global Risks Report 2023, 18th Edition, Insight Report*, World Economic Forum, Geneva 2023, pp. 13 et seq.

11 Derived from: *Where did the term polycrisis come from?*, Cascade Institute, Royal Roads University, Victoria 2024 <https://polycrisis.org/lessons/where-did-the-term-polycrisis-come-from/>, accessed: 23 April 2024.

12 M. Swilling, *Economic Crisis, Long Waves and the Sustainability Transition: An African Perspective*, in: *Environmental Innovation and Societal Transitions*, Vol. 6, Elsevier, March 2013, p. 98.

AREA OF APPLICATION	GENESIS
Politics	Jean-Claude Juncker, President of the European Commission, used it in 2018 in relation to the European migration and financial crises and Brexit ¹³ .
Philanthropic community	The Omega Resilience Funders Network adopted the term to highlight the escalating impact of many environmental, social, technological, and economic stressors ¹⁴ .
Latest research	Historians, such as Adam Tooze, highlight how the COVID-19 pandemic, the war in Ukraine, and climate change interact to create a polycrisis ¹⁵ . The Cascade Institute launched research programmes to define and understand these interconnected global threats ¹⁶ .
Media attention	Phenomenal World's newsletter <i>The Polycrisis</i> addressed issues related to the occurrence and impact of polycrisis, in particular the political economy of climate change and global inequality ¹⁷ .
Mainstream recognition	The World Economic Forum's Global Risks 2023 report put the polycrisis front and centre, highlighting the potential for cascading resource shortages due to interconnected crises ¹⁸ .
Common usage	According to Cambridge Dictionary, polycrisis is <i>a time of great disagreement, confusion, or suffering that is caused by many different problems happening at the same time so that they together have a very big effect</i> ¹⁹ . Collins Dictionary defines it as <i>the simultaneous occurrence of several catastrophic events</i> ²⁰ .

Source: Internal analysis.

13 Speech by President Jean-Claude Juncker at the opening plenary session of the Ideas Lab 2018 "Europe – Back on Track" of the Centre for European Policy Studies https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_18_1121, accessed: 23 April 2024.

14 Resilience Funders Network, *Rethinking Philanthropy for Interconnected Crises*, RFN, Omega, https://omega.ngo/resilience-funders-network/?tfa_3370=tfa_3372, accessed: 23 April 2024.

15 A. Tooze, *Shutdown: How Covid Shook the World's Economy*, Penguin Publishing Group, 2021, p. 6.

16 M. Lawrence, S. Janzwood, T. Homer-Dixon, *What is a Global Polycrisis? And How is it Different from a Systemic Risk?*, Cascade Institute, 2022, pp. 2–9.

17 T. Sahay, K. Mackenzie, *Phenomenal World "The Polycrisis"*, New York, <https://www.phenomenalworld.org/series/the-polycrisis/>, accessed: 23 April 2024.

18 *Global Risks Report 2023*, World Economic Forum, Geneva 2023. pp. 57–67.

19 *Cambridge Dictionary*, <https://dictionary.cambridge.org/>, accessed: 23 April 2024.

20 *Collins Dictionary*, <https://www.collinsdictionary.com/dictionary/english/polycrotic>, accessed: 24 April 2024.

Due to the different approaches to the term “polycrisis” in the literature, the following definition has been adopted here: a state involving multiple crises of different origins, nature, and characteristics that intertwine and reinforce one another’s effects, causing systemic disruptions that are greater than the sum of their individual contributions, resulting in an economic situation that is difficult to manage and control. The terms “metacrisis”²¹ and “permacrisis”²² are sometimes used as substitutes for polycrisis.

1.2. Causes of global instability as the beginning of an era of polycrises

The economic situation in the second decade of the 21st century results from events that took place in the recent past according to the principle that today’s decisions trigger a future crisis²³. The causes of global instability that took place between 1999 and 2023 (*i.e.*, when the term “polycrisis” was formally adopted) are complex and include a variety of economic, political, social, and environmental factors. Some causes are as follows:

- ✦ Globalisation and its effects, especially in the context of increased inequality and unstable global value chains vulnerable to shocks²⁴;
- ✦ The 2008+ financial crisis and its aftermath as a result of repeated patterns of over-indebtedness, economic bubbles, and inappropriate credit policies²⁵;
- ✦ Political instability and the rise of populism as a reaction to social and economic inequalities and a sense of marginalisation in the global economy²⁶;

21 J. Rowson, *Metacrisis, Tasting the Pickle: Ten flavours of meta-crisis and the appetite for a new civilisation*, Perspectiva Press, 2021, pp. 5 *et seq.*

22 M. Zaidi, *Our ‘Permacrisis of Polycrisis’*, *The News*, December 06, 2022, <https://www.thenews.com.pk/print/1017127-our-permacrisis-of-polycrisis> accessed: 22 April 2024.

23 P. Komorowski, *Wpływ kryzysu gospodarczego na system finansowy w Polsce a działania regulacyjne instytucji publicznych w latach 2008–2012*, in: *Wkład nauk ekonomicznych w rozwój gospodarki opartej na wiedzy*, Ed.: M. Czerwonka, OW SGH, Warszawa 2014, pp. 249–261.

24 J. E. Stiglitz. (2002). *Globalization and Its Discontents*, *Economic Notes*, Vol. 32, 1, W. W. Norton & Co., New York – London, 2003.

25 C. Reinhart, K. Rogoff. (2009). *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press, Princeton.

26 Y. Mounk. (2018). *The People vs. Democracy: Why Our Freedom Is in Danger and How to Save It*, Harvard University Press, Cambridge 2018.

- ✦ The role of technology and its impact on work and social inequalities (automation and artificial intelligence have contributed to increased social inequalities and instability in the labour market)²⁷;
- ✦ COVID-19 pandemic as a catalyst for global instability, contributing to global recession, disruption of supply chains, and increased social inequality²⁸;
- ✦ Climate change as a source of instability, affecting access to resources, population migration, and armed conflict²⁹.

In terms of the emergence of polycrises, the solutions introduced to offset the effects of the 2008–2009 Global Crisis, in particular the increase in the money supply on an unprecedented scale and a kind of optimism on the part of the elites with a lack of reforms in the real sphere, turned out to be important from the perspective of further developments. Along with the crisis, which continued in a disguised form under the cover of positive macroeconomic statistics, came the over-expansion of the US³⁰. This was due to the fact that the strategy to recover from the 2008–2009 crisis boiled down to neutralising its effects at the expense of public finances and ignored its fundamental, often non-financial, causes, such as³¹:

- ✦ The progressive global polarisation of the global economy into so-called Western and Eastern countries creating poles of consumption and production and poles of savings and debt;
- ✦ A focus on short-term profit and high margins, while ignoring differences in economic models and technological potential; and
- ✦ Inadequate regulations and poor risk assessment practices.

These factors further deepened, accompanied by unforeseen events in the second decade of the 21st century that undermined the foundations of international coordination. Particular examples of this include Brexit, systemic disinformation, new conventional wars waged with the inaction of marginalised international

27 E. Brynjolfsson, A. McAfee. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, W W Norton & Co., New York 2016.

28 R. Baldwin, B. Weder di Mauro. (2020). *Economics in the Time of COVID-19*, CEPR Press, Paris & London.

29 N. Klein. (2014). *This Changes Everything: Capitalism vs. The Climate*, Simon & Schuster, New York 2014.

30 Cf. *The Global Risk Report, 2008–2024*, World Economic Forum, Geneva 2008–2024, and C. Flint, *Introduction to Geopolitics*, Taylor & Francis, New York, 2021, pp. 154 *et seq.*

31 Cf. P. Komorowski, *Kryzys finansowy jako zjawisko ekonomiczne w ujęciu instytucjonalnym*, in: *Nauczyciele i mistrzowie ekonomii i logistyki – Profesor doktor habilitowany Doktor Honoris Causa AON Wacław Stankiewicz*, Ed. S. T. Kurek, A. Dziurny, Akademia Sztuki Wojennej, Warszawa 2016, pp. 400 *et seq.* and P. Komorowski, *Bezpieczeństwo finansowe jako funkcja państwa, na przykładzie zagrożenia COVID-19*, *International Journal of Legal Studies* No. 2(10)2021, Warszawa 2021, pp. 28 *et seq.*

bodies, the debt crisis of the PIIGS countries³² (later PIIGGS countries³³), and the European refugee crisis. The phenomenon of polycrisis has gained prominence in the face of China's growing claims to Taiwan, Russia's invasion of Ukraine, and the COVID-19 pandemic. It should come as no surprise that Jean-Claude Juncker, President of the European Commission, even before the outbreak of the COVID-19 pandemic, repeatedly spoke of polycrisis in describing the situation of the European Union in 2018. It can even be said that the mainstream media and the hitherto political mainstream, largely identified with democracy, have often become anti-democratic and detached from the realities of household life and business operations, at least in the opinion of voters in many countries, such as the US in 2024. Voters voted pragmatically, taking account of the systematically declining purchasing power of their currency and their disagreement with the erosion of property rights and freedoms. Realism and pragmatism won out over ideas. Today, the weakness of the international system manifests itself in the most routine events, from elections in Iowa through changes in government at Westminster to elections in Argentina³⁴. Another important factor, or the main axis of global change, is the tensions between an economically rising China and the hitherto dominant United States.

Table 2 shows the main causes of polycrises identified by the analysis of the above events as well as multidimensional and dynamic changes in the global economy and geopolitical situation³⁵.

32 PIIGS – Portugal, Italy, Greece, and Spain.

33 PIIGGS – Portugal, Italy, Ireland, Greece, Great Britain, and Spain.

34 Derived from the lecture (A. Tooze, *Polycrisis*) delivered at Columbia University, during the Public Lecture Series: *The Last Dystopia: Historicizing the Anthropocene Debate in a Multipolar Age*, November 2023, <https://uchv.princeton.edu/news/recap-adam-toozes-tanner-lecture-polycrisis>, accessed 20 February 2024. Cf. A. Cooley, D. Nexon, *The Real Crisis of the Global Order: Illiberalism on the Rise*, *Foreign Affairs* 101 (10), 2022, pp. 103–18, and C. Ballard-Rosa, M. Malik, S. Rickard, K. Scheve, *The Economic Origins of Authoritarian Values*, *Comparative Politics Studies* 54 (13), 2021, pp. 2321–2353.

35 M. Wolf, *Geopolitics Threatens Globalisation*, *Financial Times*, 2th November 2022.

TABLE 2: Main causes of exposure to polycrises

CAUSE	DESCRIPTION
Globalisation	With increasing economic interdependence, events in one region can have a significant impact on other regions of the world. An economic crisis in one area can quickly spread to other sectors.
Deglobalisation	While many countries are increasing their economic cooperation, there are processes that inhibit globalisation, defined as the isolation of economies, or groups of economies, resulting in inequalities in development and tensions due to differences in economic or political models ³⁶ .
Political polarisation and geopolitical tensions	Growing political divisions and trade wars disrupt global supply chains, create uncertainty for businesses and investors, increase the likelihood of war, and make it more difficult to find consensus solutions to global problems.
Uneven economic growth	Different countries are recovering from economic crises at different rates. Global solutions are difficult to adopt because solutions that benefit one economy may harm another.
Macro-financial factors	Rising debt: Many countries, especially emerging markets, have incurred significant debts in the wake of recent crises. The debt burden limits their ability to use fiscal policy to respond to new challenges. Inflation: The global economy is going through a period of volatile inflation, driven by supply chain issues, rising labour and energy costs, and high demand. This could lead to higher interest rates, which could put an additional burden on indebted countries.
Climate change	A number of problems, including water scarcity, biodiversity loss, and resource conflicts, are exacerbated by extreme weather events, rising sea levels, and environmental degradation. Environmental action places a burden on both the real and public spheres ³⁷ .
Social and economic inequalities	Growing social and political instability due to increasing inequality can lead to uprisings, revolutions, and warfare.
Pandemics	New outbreaks of infectious diseases and new diseases can have a negative impact on society, the economy, and public health.

³⁶ Z. Pozsar, *War and Industrial Policy*, Investment Solutions and Sustainability, Global, Credit Suisse Economics, 2022, pp. 2–9.

³⁷ Y. Huang, S. Tian, *Radical Trade Reform*, American Journal of Economics and Sociology 79 (1), 2020, pp. 49–72.

CAUSE	DESCRIPTION
Cyber threats	Cyber attacks have the potential to destroy key banking, communications, and infrastructure systems, leading to anarchy and paralysis.
Complexity of modern systems	Today's social, economic, and environmental systems are increasingly interconnected and complex, which makes them more vulnerable to internal and external shocks.

Source: Internal analysis derived from: K. Raczkowski, P. Komorowski, *International Economic Policy for the Polycrisis*, Routledge, London 2025, pp. 1 *et seq.*, and M. Lawrence, T. Homer-Dixon, S. Janzwood, J. Rockstöm, O. Renn, J. F. Donges, *Global Polycrisis: The Causal Mechanisms of Crisis Entanglement*, in: *Global Sustainability*, Vol. 7, Cambridge University Press, Cambridge 2024, pp. 1–16.

Table 2 shows that the causes of polycrises can have different dimensions (economic, social, environmental, and technological). Due to the interdependence of these dimensions as a result of factors, such as domino effect, mutual reinforcement, and unexpected interactions, the crisis can develop into a polycrisis, creating a chain of reactions and transferring crisis shocks to other areas. This happens when individual risks are materialised, and the materialisation of systemic risks is initiated³⁸:

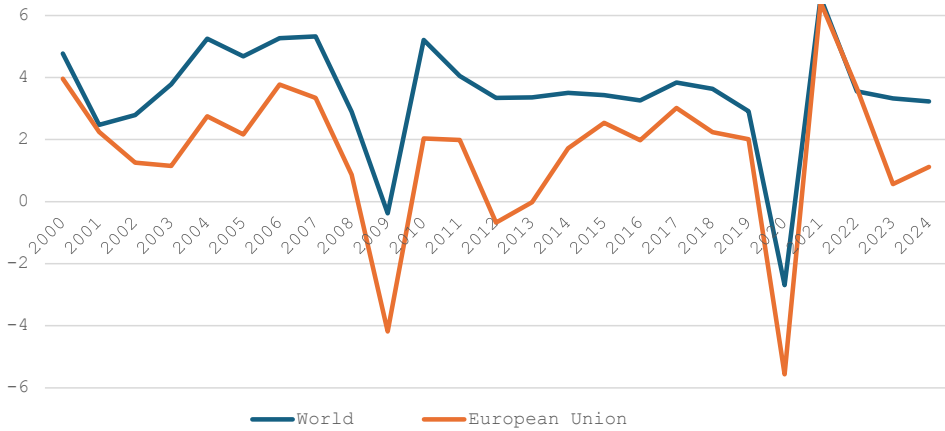
- ✦ Intra-systemic impact: a shock that affects one part or area of a single system spreads rapidly, disrupting the entire system through multiple branching chains of cause and effect or some form of contagion through the system’s causal network.
- ✦ Inter-systemic impact: a shock of the initial system can spread beyond its boundaries, disrupting other systems.

The effects of the cumulative crisis processes can be manifold. The effects that are most often observed include a decline in aggregate demand, unstable, mostly rising, margins, falling valuations of monetary and equity instruments, volatile prices, falling investment, falling output, rising unemployment, declining discounted cash flows, falling GDP growth (as shown in Figure 1), and rising uncertainty (as shown in Figure 2).

It is clearly seen that changes in the EU’s aggregate GDP are particularly sensitive to crisis situations (especially the 2008+ financial crisis and the COVID-19 pandemic). This means that the EU urgently needs to develop new standards and governance rules that are time-efficient and do not lead to systemic risks for individual

³⁸ M. Lawrence, T. Homer-Dixon, S. Janzwood, J. Rockstöm, O. Renn, J. F. Donges, *Global Polycrisis: The Causal Mechanisms of Crisis Entanglement*, in: *Global Sustainability*, Vol. 7, Cambridge University Press, Cambridge 2024, p. 23.

FIGURE 1: Dynamics of aggregate gross domestic product for the world and the European Union at constant prices from 2000 to 2024 (in per cent)

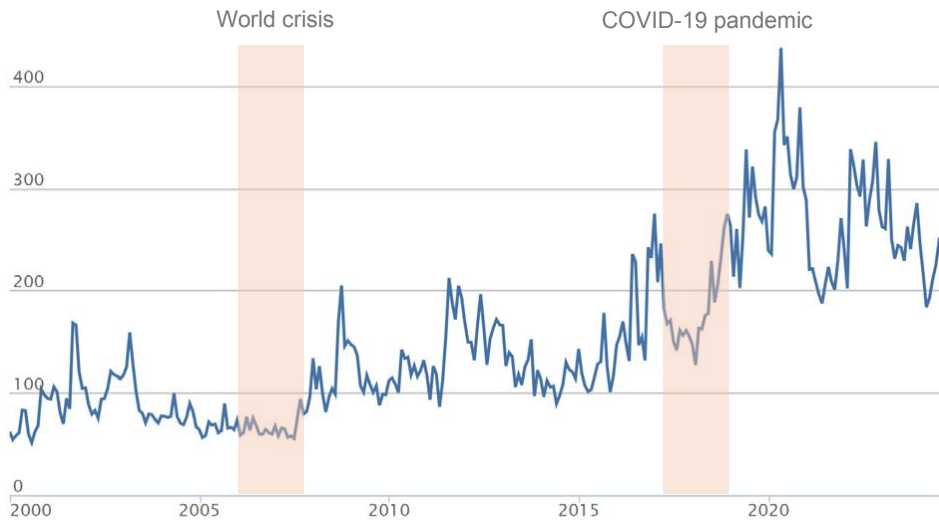


Source: Internal analysis derived from World Economic Outlook database, October 2024.

EU countries at the expense of glorifying other EU countries and building their values. If the changes are not made, the EU will be vulnerable to attacks on critical economic sectors and energy infrastructure, disruption of supply chains, financial shock, and destabilisation of financial markets, which will translate into institutional destabilisation and political shock, marginalising the EU on the international stage in the long term. The information that the EU is threatened with war with Russia should not be taken seriously. However, the EU's failure to mitigate the risk of a future war with anyone by urgently building up its defence capabilities (coordinated military resources, a single defence strategy and doctrine, technology, equipment, and economic, social, and allied resources) seems completely irresponsible.

Various crises can reinforce one another leading to further escalation and, in combination with various factors, to unexpected consequences in many areas. The spread of a polycrisis is even more complicated than that of a one-dimensional crisis. The ultimate effects of a polycrisis may not have direct causal, functional, and geographical links to its original sources³⁹.

39 P. Komorowski, *Przebieg kryzysu gospodarczego w wymiarze cyklu życia*, in: *Wiedza i bogactwo narodów, Kapitał ludzki, globalizacja i regulacja w skali światowej*, *Ekonomia i finanse*, Ed.: R. Bartkowiak, P. Wachowiak, OW SGH, Warszawa 2013, p. 285, Cf. M. Lawrence, M. Shipman, T. Homer-Dixon, *Introduction to Polycrisis Analysis A Guide to the Cascade Institute's Approach*, Cascade Institute, 2024, p. 12.

FIGURE 2: Economic Policy Uncertainty Index for the World in 2000–2024

Source: Source: Internal analysis derived from: <https://www.policyuncertainty.com/> accessed: 1 October 2024.

As a result, a polycrisis leads to negative events on many dimensions simultaneously. Furthermore, in a polycrisis (even more so than in a one-dimensional crisis), it is not possible to predict the further development of a polycrisis and conduct an effective anti-crisis policy⁴⁰.

1.3. Consequences of polycrisis

The occurrence of a polycrisis, due to its multi-dimensional nature and greater complexity than in a one-dimensional crisis, can lead to deeper and multifaceted negative consequences for the economy and the social, political, and environmental spheres, creating a set of adverse effects⁴¹. Due to the differences between polycrises resulting from differences in origins, time of occurrence, condition

40 M. Lawrence, T. Homer-Dixon, S. Janzwood, J. Rockstöm, O. Renn, J. F. Donges, *Global Polycrisis: The Causal Mechanisms of Crisis Entanglement*, in: *Global Sustainability*, Vol. 7, Cambridge University Press, Cambridge 2024, p. 23.

41 K. Kotarski, *The New Era of Polycrisis and How to Tackle it*, *Future Europe Journal*, Issue 3, pp. 1 et seq.

of the world economy and national economies, political and social reaction and, consequently, the course of the process, it is difficult to determine unequivocally the consequences of a polycrisis. However, for the purposes of this chapter, possible scenarios arising from the crisis factors have been identified.

One very likely consequence is **economic instability**, which may lead to a recession of the economy or even depression, through a sharp slowdown and contraction of the economy. Another likely consequence is volatile prices due to inadequate management of fiscal and monetary policy in the face of rapid polycrisis-induced changes, leading to inflationary or deflationary pressures. In the face of declining economic dynamism and a change in public mood due to negative crisis processes, there may also be a reduction in investment leading to rising unemployment⁴².

In the face of multidimensional disruptions, to pursue adequate **fiscal and monetary policies** can also be a challenge. Pursuing anti-crisis policies that offset the effects of a polycrisis may lead to increased fiscal spending, resulting in increased budget deficits and unbalanced levels of public debt. Volatile public finances may lead to a loss of confidence in the way the economy is managed, resulting in currency devaluation, increased import prices, and increased inflationary pressures⁴³.

The effects of a polycrisis can also be observed in the sphere of **investments and businesses**. Due to increased risk and uncertainty, domestic problems may lead to a decrease in foreign capital inflows, resulting in a decline in foreign investment. Faced with a difficult economic environment, businesses may struggle with an unpredictable regulatory environment, increased costs, and reduced consumer demand, which may lead to business closures and bankruptcies. In an unstable environment, R&D spending may be reduced, resulting in a decline in innovation and lower economic growth⁴⁴.

A polycrisis can lead to a sharp decline in the dynamics of economic activity, as observed in the decline in GDP dynamics, and a reduction in the potential for **economic growth** in the longer term. Multidimensional crisis phenomena may reduce productivity by disrupting economic activity and reducing investment

42 N. Goodwin, J. Harris, P. J. Rajkarnikar, B. Roach, T. Thornton, *Essentials of Economics in Context*, Routledge, New-York 2021, pp. 409–435.

43 J. Komorowski, P. Komorowski, International financial system versus economic stability, in: *International Economic Policy for the Polycrisis*, Ed.: K. Raczkowski, P. Komorowski, Routledge, London 2025, pp. 114–138.

44 W. Orłowski, R. Pasternak, K. Plaht, D. Szubert, *Procesy inwestycyjne i strategie przedsiębiorstw w czasach kryzysu*, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa 2010, pp. 23–61.

in human capital, physical capital, and technology. In the long term, the economy may lose its competitive advantages leading to difficulties in rebuilding the conditions for growth⁴⁵.

The consequences of a polycrisis may extend beyond the economic sphere and take the form of **social and political unrest**. Pessimistic sentiment caused by economic difficulties, growing inequalities, and ineffective economic policies can lead to widespread discontent and undermined trust in the actions of government and state institutions. The situation may escalate into a political crisis, leading to instability, political polarisation of society, and frequent changes of government. In view of widespread social impoverishment, widening inequalities may lead to social divisions, resulting in conflicts, increased tension and discontent, and fragmentation of society⁴⁶.

Economic constraints may lead to negative consequences in the social sphere by affecting **human capital and public services**. Due to economic constraints caused by increased spending on anti-crisis policies, public services may be underfunded, resulting in the degeneration of the education and health systems. Faced with a difficult situation, skilled professionals may emigrate in search of better opportunities, leading to a loss of human capital. The growing demand for welfare and social protection programmes may strain public resources, limiting their effectiveness and reach⁴⁷.

Domestic problems caused by a polycrisis may have negative effects on **international relations** due to a loss of credibility abroad, which may affect diplomatic and trade relations. A possible scenario for anti-crisis measures is the introduction of protectionist tools, which may lead to trade distortions, affecting exports and imports. It should also be stressed that the severe consequences caused by crisis processes have the potential to undermine national sovereignty and long-term economic stability by increasing dependence on foreign aid⁴⁸.

45 *World Development Report 2022, Finance For An Equitable Recovery*, World Bank Group, Washington 2022, pp. 49–78.

46 *Polycrisis and long-term thinking*, United Nations Development Programme, New York 2022, pp. 4 et seq.

47 G. Wood, F.L. Cooke, D. Brou , J. Wang, P. Ghauri, *Rethinking contexts and institutions for research on human resource management in multinational enterprises in an age of polycrisis: reflections and suggestions*, *The International Journal of Human Resource Management*, 2024, pp. 1–34.

48 E. Utz, *The great reset and the new global economic order*, in: *International Economic Policy for the Polycrisis*, Ed.: K. Raczkowski, P. Komorowski, Routledge, London 2025, pp. 37–60.

Economic, social, and political consequences may also **affect the environment** and lead to deprioritisation of environmental policies, exacerbating environmental degradation. The mismanagement of natural resources as a result of the focus on other areas in which the effects of the crisis occurred and the reduced financial resources can further reinforce the negative economic consequences⁴⁹.

The above analysis, reduced to the identification of the most likely scenarios for the effects of a polycrisis, shows that the natures of one-dimensional crises and polycrisis are similar. In terms of the life-cycle model of the crisis, they have similar stages, but there are also some differences (Table 2).

TABLE 2: Differences between a one-dimensional crisis and a polycrisis

SCOPE	ONE-DIMENSIONAL CRISIS	POLYCRISIS
Origins	One dimension	Multiple dimensions (economic, social, political, and environmental) with no direct (causal or functional) links
Course of the crisis	Complex and unpredictable, the crisis spreads through a domino effect	Much more complex and difficult to predict as a result of the simultaneous occurrence of many crises of a different nature, spreading individually through a domino effect and reinforcing one another, which leads to the transformation of separate crises into one mainstream
Effects	Negative effects in the short and long term, mainly qualitative in nature, mostly affecting one dimension	Negative effects in the short and long term, mainly qualitative in nature, multi-dimensional (economic, social, political, and environmental dimensions)
Anti-crisis policy	Costly, mainly burdening public finances and the real economy	Much more costly despite public finances and the real economy, the burden may be placed on society and the ecosystem

Source: Internal analysis.

49 Cf. S. Dekeyrel, S. Šipka, D. Brady, P. Lausberg, L. Rayner, *The Green Deal in times of polycrisis: Aligning short-term responses with long-term commitments*, Sustainable Prosperity for Europe Programme, European Policy Centre, 2024, pp. 15–16, and s. D. Hening, *Polycrisis: Prompts for an emerging worldview*, *Anthropology Today*, Vol. 39, No. 2, April 2023, 4 et seq.

Table 2 shows that a polycrisis has diverse origins, most often with no direct causal or functional links. It can be said that the genesis of a polycrisis is the occurrence of multiple independent one-dimensional crises in different dimensions (economic, social, political, and environmental) on a global scale, generating a much larger number of quantitative and qualitative effects. In the course of a polycrisis, many independent crises of a different nature occur simultaneously, spreading through the domino effect and reinforcing one another. The intertwining of crisis processes results in the transformation of separate crises into one mainstream. The effects are likely to be more destructive in the short and long term, compared to a one-dimensional crisis, and thus more difficult to avoid due to their multidimensionality and the difficulties in conducting effective anti-crisis policies.

1.4. Index of uncertainty in the global economy

The unpredictability of markets, economic policies, and geopolitical events not only prompts another contestation of the theory of rational expectations⁵⁰, but also the understanding that the expectations themselves are forward-looking, however, based on historical and adaptive tendencies of analysis⁵¹. It also proves that the full-information rational expectations hypothesis (FIRE) and the resulting regime shifts in FIRE models, making it possible to change the probability distribution of variables if prior uncertainty has been introduced, and decision makers can take it into account and contrast it with the information available at the time of the forecast. This approach demonstrates that by changing the parameters in FIRE models, it is possible to predict ex-post forecast error variables⁵².

Using real option value theory, it has been proven that uncertainty reduces the current rate of investment, increasing the value of waiting for new (in the belief further uncertain) information⁵³. Thus, high uncertainty in the implemented

50 G. C. Chow, Y. K. Kwan. 1997. *Rational Expectations is not generally valid for econometric models: evidence from stock market data*, Blackwell Publishers, Pacific Economic Review, 2:3, Oxford, Malden.

51 T. Frömmel. 1997. *The Rational Expectations Hypothesis: Theoretical Critique*, E-LOGOS – Electronic Journal for Philosophy, Vol. 24(2) 4–12 | ISSN 1211-0442 (DOI 10.18267/j.e-logos.436).

52 I. Hajdini, A. Kurmann. 2024. *Predictable Forecast Errors in Full Information Rational Expectations Models with Regime Shifts*. Working Paper No. 24-08. Federal Reserve Bank of Cleveland. <https://doi.org/10.26509/frbc-wp-202408>.

53 Bernanke, B. S. (1983). *Irreversibility, uncertainty, and cyclical investment*. The quarterly journal of economics, 98(1), 85–106. <https://doi.org/10.2307/1885568>.

socio-economic policies is a kind of barrier to entry into a given market, introduces risks in the level of inflation or consumer demand, limiting investment in existing markets and creating delays or blockages for investment into new markets⁵⁴. Thus, uncertainty adversely affects bilateral trade; it is non-linear in nature and more threatening to Emerging Markets and Developing Economies (EMDEs) and those countries without natural resources⁵⁵.

There are several uncertainty indices developed to measure economic and policy uncertainty on the global scale, and the main ones include the Economic Policy Uncertainty (EPU) Index (26 countries)⁵⁶; the World Uncertainty Index (WUI) (143 countries)⁵⁷; the Global Economic Policy Uncertainty (GEPU) Index (20 countries)⁵⁸; the Geopolitical Risk (GPR) Index, which provides aggregate data for the world, however, it does not analyse individual countries⁵⁹; the Financial Stress Index (FSI) – the coverage of the FSI varies depending on the institution developing the index (International Monetary Fund, European Central Bank, Federal Reserve Bank of Kansas City, Bank of Canada, Country-Specific FSIs)⁶⁰; or an index of stock market expectations for volatility based on options on the S&P 500 index – VIX (Volatility Index)⁶¹.

For the purpose of this study, The Economic Policy Uncertainty Index (EPU) will be used, with values averaged over the period between 2008 and 2023 for five global economies, such as the United States, China, Japan, Germany, and the United Kingdom (Table 3). EPU is described here as a measure used to assess the level of economic policy uncertainty in various countries. The equation

54 Novy, D., & Taylor, A. M. (2020). *Trade and uncertainty*. Review of Economics and Statistics, 102(4), pp. 749–765. https://doi.org/10.1162/rest_a_00885.

55 I. Nana, R. Ouedraogo, S. J. Tapsoba. 2024. *The Heterogeneous Effects of Uncertainty on Trade*, International Monetary Fund, WP/24/139.

56 S. R. Baker, N. Bloom, S. J. Davis. 2016. *Measuring Economic Policy Uncertainty*. Quarterly Journal of Economics, Vol. 131, Issue 4, November, pp. 1593–1636, <https://doi.org/10.1093/qje/qjw024>.

57 H. Ahir, N. Bloom, & D. Furceri. (2018). *The World Uncertainty Index*, IMF Working Papers. Available at SSRN: <https://ssrn.com/abstract=3275033> or <http://dx.doi.org/10.2139/ssrn.3275033>.

58 S. R. Baker, N. Bloom, S. J. Davis & S. J. Terry. (2019). *Global Economic Policy Uncertainty Index: Current Price Adjusted GDP*. <https://fred.stlouisfed.org/series/GEPUCURRENT>.

59 D. Caldara & M. Iacoviello. 2018. *Measuring Geopolitical Risk*, International Finance Discussion Papers 1222r1, Board of Governors of the Federal Reserve System (U.S.), revised 23 Mar 2022.

60 *Global Financial Stability Report*, IMF 2024.

61 R. E. Whaley. (1993). *Derivatives on Market Volatility and Market Volatility Indexes*. Journal of Derivatives, 1(1), pp. 71–84.

to calculate the EPU is typically constructed based on the analysis of the frequency of specific keywords related to uncertainty and economic policy in newspaper articles as well as data on fiscal and monetary policy. For the global index, average values for major economies are used.

To construct the EPU equation, the following variables and categories will be defined:

a) **Media Coverage (MC):** The frequency index of keywords related to economic uncertainty, fiscal policy, and monetary policy in news articles. The keywords typically include terms related to economic policy (such as “deficit” or “tax”), terms associated with uncertainty (like “uncertain” or “risk”), and references to key policy-related economic terms (*e.g.*, “monetary policy” or “regulation”). The rationale behind using media coverage is that it serves as a proxy for the level of public and investor awareness about economic policy uncertainty. When the media frequently discusses uncertainty, it reflects heightened concerns about the stability or direction of policy. The calculation relies on the four sub-variables, *i.e.*, (a) keywords related to economic policy; (b) keywords related to uncertainty; (c) number of relevant articles; and (d) total number of articles published.

b) **Tax Code Expirations (TE):** An indicator concerning changes in the tax code and the expiration dates of taxes. This includes scheduled changes to tax rates, credits, deductions, and other tax-related policies. When tax laws are set to expire or undergo significant changes, it can create uncertainty about future tax liabilities. The (TE) component highlights the extent to which uncertainty in future tax policies can affect economic decision-making. Businesses and individuals may delay investments or spending if they are unsure about future tax rates. To build this indicator, three sub-indicators were used: (a) the number of tax provisions set to expire; (b) the economic significance of each provision; and (c) the date of expiration.

c) **Disagreement Among Forecasters (DF):** A measure of disagreement among macroeconomic forecasts. This variability represents differences in opinions about key economic indicators, such as GDP growth, inflation, unemployment rates, and fiscal balance projections. Higher levels of disagreement suggest greater uncertainty about the economic outlook. The DF component provides insight into the level of uncertainty surrounding economic projections. When experts have widely divergent views, it reflects challenges in predicting the future economic environment, which can make it harder for policymakers and businesses to make informed decisions. Total variables for DF calculation include three sub-variables: (a) forecasts for various indicators; (b) dispersion measure, and (c) weighting.

The algorithms and systems used in constructing the EPU Index leveraged, and they include Natural Language Processing (NLP) and machine learning for textual analysis of media content (algorithms such as keyword extraction, sentiment analysis, and topic modelling helped find relevant terms). Data mining techniques for legislative tracking of tax policies (using legislative data from official sources, algorithms scanned for scheduled changes in tax provisions, such as changes in tax rates, deductions, and credits as well as legislative databases and government publications) were systematically mined to track tax policies and their expiration dates. Statistical analysis to measure disagreement among economic forecasts were calculated using forecasts collected from professional forecasters. Algorithms calculated the dispersion, *i.e.*, standard deviation, variance, or interquartile range of forecasts for key economic indicators. Statistical techniques, such as principal component analysis (PCA), were used to assign weights to different economic variables, *e.g.*, GDP, inflation, and unemployment. Statistical time-series models, such as autoregressive integrated moving average (ARIMA), were used to study the evolution of forecast dispersion over time, helping to detect changes in uncertainty levels based on the spread of economic predictions.

By integrating these methods, the EPU Index was designed to provide a comprehensive, data-driven measure of economic policy uncertainty that could adapt to changing information sources and economic conditions. Together, these three components – Media Coverage (MC), Tax Code Expirations (TE), and Disagreement Among Forecasters (DF) – provide a comprehensive view of economic policy uncertainty. The EPU index combines them to reflect fluctuations in uncertainty over time, based on both real-time events (captured by media and tax code changes) and expectations about the future (captured by forecaster disagreement).

By aggregating these dimensions, the EPU index aims to measure the impact of policy-related uncertainty on economic decision-making, investment, and business activity. The EPU index for a given economy can be described as a weighted average of the logarithm of these three components:

$$EPU = (w_1 \cdot \log(MC) + w_2 \cdot \log(TE) + w_3 \cdot \log(DF))$$

Where are weights assigned to each category, reflecting their relative importance in the index.

For simplicity, we can assume equal weights, which leads to the equation:

$$EPU_i = \frac{1}{3}(\log(MC_i) + \log(TE_i) + \log(DF_i))$$

where i represents the given economy.

In our analysis, we have examined only five economies. If one assumes according to the UN classification that we have 193 countries that are fully internationally recognised, plus the remaining two, such as Vatican City and Palestine, then one would have to assume a number of at least 195 countries in the Economic Policy Uncertainty Index. The global EPU would then be the arithmetic mean of the individual EPUs for these five economies:

$$EPU_{global} = \frac{1}{195} + \sum_{i=1}^{195} EPU_i$$

TABLE 3. EPU average values for the five major global economies (2008–2023)

COUNTRY	MC	TE	DF	EPU*
United States	150 $\log(150) = 5.0106$	30 $\log(30) = 3.4012$	10 $\log(10) = 2.3026$	3.57
China	120 $\log(120) = 4.7874$	25 $\log(25) = 3.2188$	12 $\log(12) = 2.4849$	3.50
Japan	130 $\log(130) = 4.8675$	20 $\log(20) = 2.9957$	9 $\log(9) = 2.1972$	3.35
Germany	140 $\log(140) = 4.9416$	22 $\log(22) = 3.0910$	8 $\log(8) = 3.0910$	3.37
United Kingdom	145 $\log(145) = 4.9767$	28 $\log(28) = 3.3322$	11 $\log(11) = 2.3979$	3.57

*Lower index values mean a higher ranking and a more potentially friendly investment environment.
Source: Own study.

A higher EPU suggests that businesses and investors may face more difficulty in making decisions due to unclear or unstable economic policies. Conversely,

a lower EPU indicates a more stable and predictable economic policy environment. Japan (3.35) and Germany (3.37) demonstrate the best performance in terms of lower economic policy uncertainty, suggesting a more stable and predictable policy environment, which could be more favourable for businesses and investors. The United States (3.57) and the United Kingdom (3.57), with the highest EPUs, indicate more frequent or significant policy-related uncertainties during the period analysed. China (3.50) has a moderate level of policy uncertainty, higher than Japan and Germany but lower than the United States and the United Kingdom.

However, it is important to remember that the EPU indicator contributes approximately 38 per cent to the overall composite measure of uncertainty in this example (in the economy). This means that the Economic Policy Uncertainty (EPU) indicator accounts for a significant portion of the total uncertainty captured by combining several different indicators but should not be used as an infallible oracle of forecasting because it does not take into account a large portion of the other variables that affect uncertainty. Indeed, if the contribution (per cent) of the EPU for uncertainty alone is high, it means that policy-related factors have a greater influence in shaping perceptions of uncertainty than other factors, such as geopolitical risk or financial market tensions. Therefore, with multiple shocks and crises occurring simultaneously, it would also be appropriate for studies to use a composite uncertainty index calculated using a weighted sum of normalised indices (in our case, the six main uncertainty indices listed) – as presented in Table 4.

TABLE 4. Composite uncertainty index calculated using a weighted sum of normalised indices

UNCERTAINTY INDEX TYPE (UIT)		WEIGHT	NORMALISED VALUES
EPU Index	W1	0.30	0.7
WUI World Uncertainty Index	W2	0.20	0.5
(GEPU) Global Economic Policy Uncertainty	W3	0.20	0.6
(GPR) Geopolitical Risk Index	W4	0.10	0.4

UNCERTAINTY INDEX TYPE (UIT)		WEIGHT	NORMALISED VALUES
(FSI) Financial Stress Index	W5	0.10	0.5
VIX (Volatility Index)	W6	0.10	0.3

CALCULATING THE COMPOSITE INDEX (CI)

$$CI = W1 \cdot EPU_{norm} + W2 \cdot WUI_{norm} + W3 \cdot GEPU_{norm} + W5 \cdot FSI_{norm} + W6 \cdot WIX_{norm}$$

Source: own study

The calculation of strength and weighting shows the contribution of each uncertainty index to the combined uncertainty measure, allowing comparison with other indices. This algorithmic approach provides a systematic way to assess the importance-in our case of the EPU relative to other uncertainty indices and vice versa.

1.5. Risks of polycrisis and challenges for economic policy

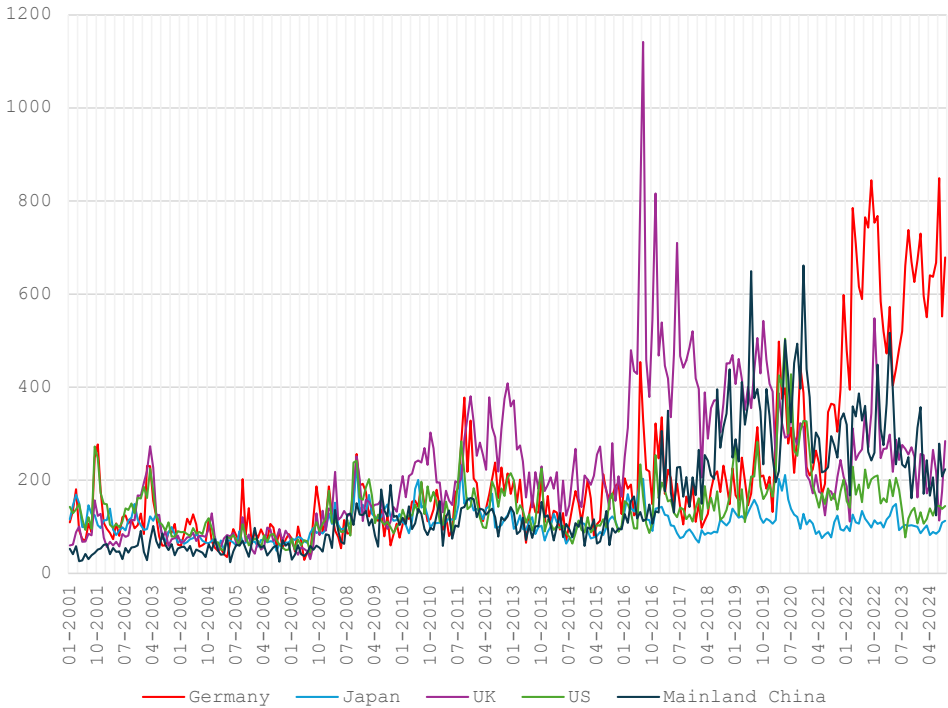
With the advancement of globalisation and technological development, the modern world becomes a complex network of interconnected elements, and it is uncommon for major disruptions to affect just one aspect of life. Consequently, due to imbalances and tensions, changes in one area (environment, politics, or economy) often have far-reaching effects on other areas. This complexity increases the risk of polycrisis. In the face of increasing uncertainty, it becomes more difficult to pursue effective economic policies that build a crisis-proof system and the conditions for stable economic growth⁶².

It is difficult to measure the impact of the uncertainty on the economy. The Economic Policy Uncertainty Index (EPU) gathers qualitative data on uncertainty

⁶² Cf. N. Acocella, *Economic Policy in the 21st Century, The Four Great Challenges*, Cambridge University Press, Cambridge 2022, pp. 7 et seq, and W. Mańkowski, *Polityka gospodarcza jako działanie państwa na tle globalnych zmian*, Artykuły – Dyskusje – Eseje, Civitas Hominibus No. 14/2019, pp. 40–59.

on the basis of emerging expert, media, and publication information on uncertainty over a given period⁶³.

FIGURE 3: Economic Policy Uncertainty (EPU) Index values for Germany, Japan, the UK, the US, and China from 2000 to 2024



Source: Internal analysis derived from: <https://www.policyuncertainty.com/>, accessed: 2 October 2024.

Referring to the causes of global instability, the key factors shaping the world today are as follows: globalisation, which has increased social inequalities and made the world economy more vulnerable to shocks; the global financial crisis of 2008 and its long-lasting effects resulting from excessive financial risks and regulatory failures; increasing political instability and growing support for populist

63 S. R. Baker, N. Bloom, S. J. Davis, *Measuring Economic Policy Uncertainty*, Economic Policy Uncertainty, 2016, <https://www.policyuncertainty.com/methodology.html> accessed: 2 February 2024.

movements, which are an expression of social discontent with growing inequality and feelings of exclusion; technological transformations, such as automation and artificial intelligence, which are revolutionising the labour market while exacerbating existing inequalities; the COVID-19 pandemic, which acted as a catalyst for a number of global crises, including economic, social, and health crises; the climate crisis, which represents one of the greatest challenges of the modern era, leading to increased conflict, migration, and threats to food security.

Figure 3 shows that there is an increase in the value of the Economic Policy Uncertainty Index for selected economies of Germany, Japan, the UK, the US, and China during periods of increased risk from 2000 to 2024. The increases coincide with significant global events, such as 9/11 in 2001, particularly for the US, the 2008 economic crisis, Brexit and the 2016 US presidential election, the COVID-19 pandemic in 2019, and the war in Ukraine in 2022. The dynamics of the graphs indicate how the level of uncertainty is influenced by events identified as causes of global instability, as listed in section 2 of this chapter. The analysis of the values of the Economic Policy Uncertainty Index does not provide any quantification of the likelihood of the next crisis, but it can provide some indication of the actual increase in uncertainty and thus an increase in the trend in public sentiment with respect to future negative events.

Conclusions

In the 21st century, the concept of polycrisis has developed into an important research issue and has become the subject of much research and analysis. Economic, social, and geopolitical conditions resulting from global changes cause an unprecedented evolution of reality towards the interconnectedness of micro-economic, macro-economic, and systemic risks. In the face of increased cyclical volatility, advancing globalisation, political instability, the effects of the 2008+ crisis and the COVID pandemic, climate change, advancing technological progress, and increasing uncertainty, the crisis processes materialise in various areas of the economic sphere. The origins of polycrises are very often found outside the economy but are intertwined with it and shape its real system. The multidimensionality and the reinforcing mechanism of a polycrisis affect its complexity. The structure and nature of a polycrisis require an interdisciplinary approach to research.

The conclusions about the nature of a polycrisis are as follows:

- ✦ A polycrisis is a multi-dimensional phenomenon the origins of which may lie in various areas of the economy and beyond (economic, socio-cultural, political, ecological, and systemic perspective).
- ✦ In the course of a polycrisis, many independent crises of a different nature occur simultaneously, spreading through the domino effect and reinforcing one another (like in quantum systems, multiplier effects, and non-linearity).
- ✦ The effects of a polycrisis are more difficult to manage and mitigate compared to a one-dimensional crisis.
- ✦ The ultimate effects of a polycrisis may not have direct causal, functional, and geographical links to its original sources.

The risk of polycrisis is difficult to estimate, but the research shows that high levels of uncertainty, as measured by the Economic Policy Uncertainty Index, coincide with periods of crisis and turmoil. The Economic Policy Uncertainty Index, averaged in 2008–2023 for five global economies (the United States, China, Japan, Germany, and the United Kingdom), demonstrates that media information, changes in the tax system, and disagreement among forecasters can provide a comprehensive picture of economic policy uncertainty. The theoretical underpinnings of the Economic Policy Uncertainty Index demonstrate the stability and predictability of the economic policy environment, with best results achieved by Japan and Germany. However, their practical implementation based on the more realistic weights from 2000–2024 assigned to each category (<https://www.policyuncertainty.com/>) proves that Japan had the lowest uncertainty index, while Germany had the highest values in the last few years.

This research shows that cognitive errors and heuristics (both theoretical and practical) are inherent in the process of polycrisis research as the parallel analysis of theoretical errors of models must take into account the need to revise the assumptions and the assigned weights (which was the case in this research). Attention should also be paid to rare but significant (one-off) events that may underestimate risks. Their mitigation requires an interdisciplinary approach that includes sensitivity analysis, calibration of models, inclusion of unpredictable events, and raised awareness of cognitive errors.

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Social changes caused by fundamental convergence in the functioning of the world economy

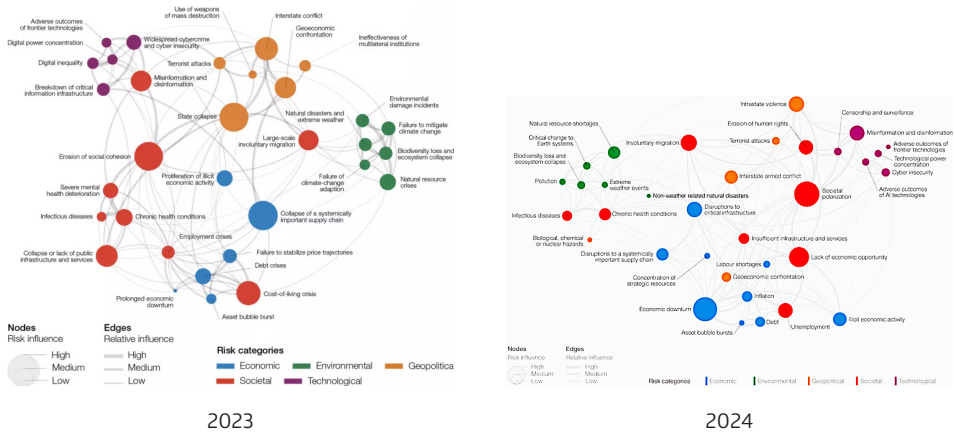
Olha Ilyash

Introduction

The social divisions that have been exacerbated by periodic turmoil have been laid bare by the fallout of the COVID-19 crisis and the ongoing Russian full-scale invasion in Ukraine. However, the international system has displayed unexpected durability thus far. While these events have not yet resulted in significant regional clashes or widespread global destabilisation akin to the initial outbreak of the war in Ukraine and the COVID-19 pandemic, their potential long-term implications may introduce additional disruptions.

The Global Risks Report 2023 by the World Economic Forum (WEF) highlighted numerous risks that the world encountered at the start of 2023. These risks included inflation, a crisis in the cost of living, trade wars, capital outflows from markets, social conflicts on a large scale, as well as geopolitical and energy upheavals. It is evident that these risks are further intensified by the emergence of new global threats, particularly the challenges posed by Russia's war in Ukraine (Figure 1).

FIGURE 1. Global risks landscape – interconnections map (Global Risks Perception Survey, 2023–2024)



Source: Author’s analysis based on ¹ and ².

The most significant challenges encompass an alarming level of debt. In the Stability and Convergence Programmes (SCPs), most Member States plan further declines in government deficits in 2025–2026. Deficits would be brought or maintained below 3 per cent of GDP in 2023. Bulgaria, Slovakia, Estonia, and France are the only four EU countries for which the SCPs project a deficit above 3 per cent of GDP in 2026³. The risk of the lack of global investment, extremely low rates of economic growth, and de-globalisation trends lead to the regression in human development. It appears that the geopolitical and economic trends in the upcoming decade will serve as catalysts for extensive social crises and lead to the decrease in the global economic security.

The new economic era that results from geopolitical fragmentation may be characterised by a growing difference between the rich and poor countries or

1 Global risks report 2023. World Economic Forum. (2023). URL: <https://www.weforum.org/publications/global-risks-report-2023/>

2 Global risks report 2024. 19th Edition. World Economic Forum. (2024). URL: <https://www.weforum.org/publications/global-risks-report-2024/>

3 The 2023 Stability & Convergence Programmes European Economy. An Overview, with an Assessment of the Euro Area Fiscal Stance. EU Commission. Economic and Financial Affairs. Institutional Papers 253, July 2023 URL: https://economy-finance.ec.europa.eu/document/download/93afdd65-d376-4a8d-bf0f-a12264709814_en?filename=ip253_en.pdf

regression in human development that has been noted down for the first time in decades. Geoeconomic fragmentation manifests itself in the intensified geopolitical polarisation, often resulting in reduced trade and lower incomes. However, the biggest impacts tend to be in emerging markets and developing countries – real *per capita* income losses in mid-sized emerging market and developing economies in Asia are 80 per cent higher than those in mid-range developed economies, and real *per capita* income losses in mid-sized emerging market and developing economies in Africa are 120 per cent higher⁴. This suggests that the costs of trade fragmentation may fall disproportionately on countries least able to bear them.

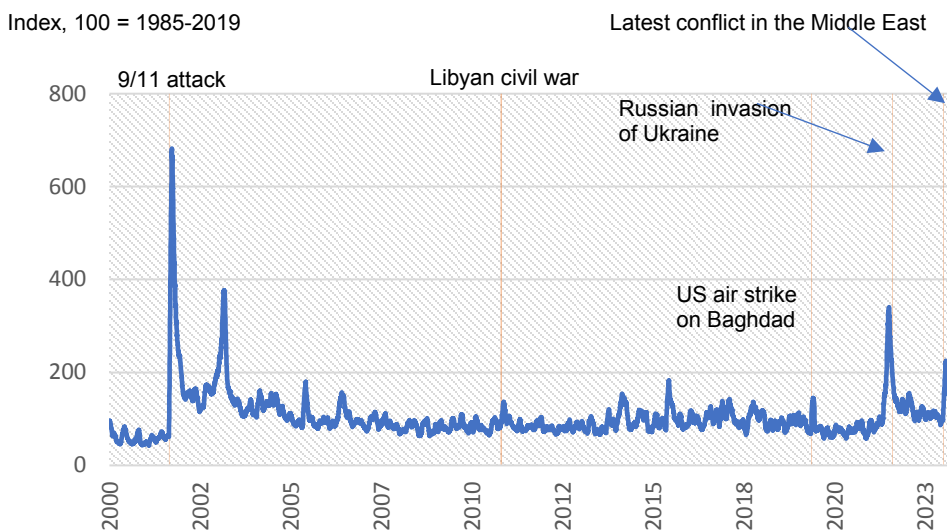
The increasing prevalence of geoeconomic division (GD) is now recognised around the world, and the European Union is not exempt from its effects. Because of its high degree of openness, the EU is exposed to the GD. The most effective way for the EU to defend itself against GD is to promote a single market ensuring that products are safe and comply with the rules⁵, including procurement rules; otherwise, geopolitical division will lead to geoeconomic warfare and increase the likelihood of multiple conflicts over the next years. Thus, economic warfare is now the most common form of conflict that increases the tension between global powers and state actors on the markets and impose the impact of the social threats on global economic security. This, in turn, requires the solidarity of partner countries in a global context in order to face the new challenges of military conflicts together, in particular the Russia's full-scale invasion of Ukraine.

2.1. Global changes in the world economy in the context of geoeconomic fragmentation

Geoeconomic fragmentation of the global economy due to the Russia's war against Ukraine and geopolitical tension can worsen and significantly increase the geopolitical risks (Figure 2).

4 S. Hakobyan, S. Meleshchuk, & R. Zymek. (2023). Divided We Fall: Differential Exposure to Geopolitical Fragmentation in Trade. IMF Working Papers, 2023(270), A001. URL: <https://doi.org/10.5089/9798400262302.001.A001>

5 Chikako Baba; Ting Lan; Aiko Mineshima; Florian Misch; Magali Pinat; Asghar Shahmoradi; Jiaxiong Yao; Rachel van Elkan (2023). Geoeconomic Fragmentation: What's at Stake for the EU. Working Paper No. 2023/245. URL: <https://www.imf.org/en/Publications/WP/Issues/2023/11/29/Geoeconomic-Fragmentation-Whats-at-Stake-for-the-EU-541864>

FIGURE 2. Geopolitical risk index and conflicts

Source: Author's analysis based on ⁶.

The escalation of these conflicts can have significant consequences for commodity markets and the economic activity. So far, the conflict in the Middle East has had a modest impact on commodity prices, however, historical precedent suggests that an escalation could lead to severe disruptions to oil supplies and sharp increases in commodity prices.

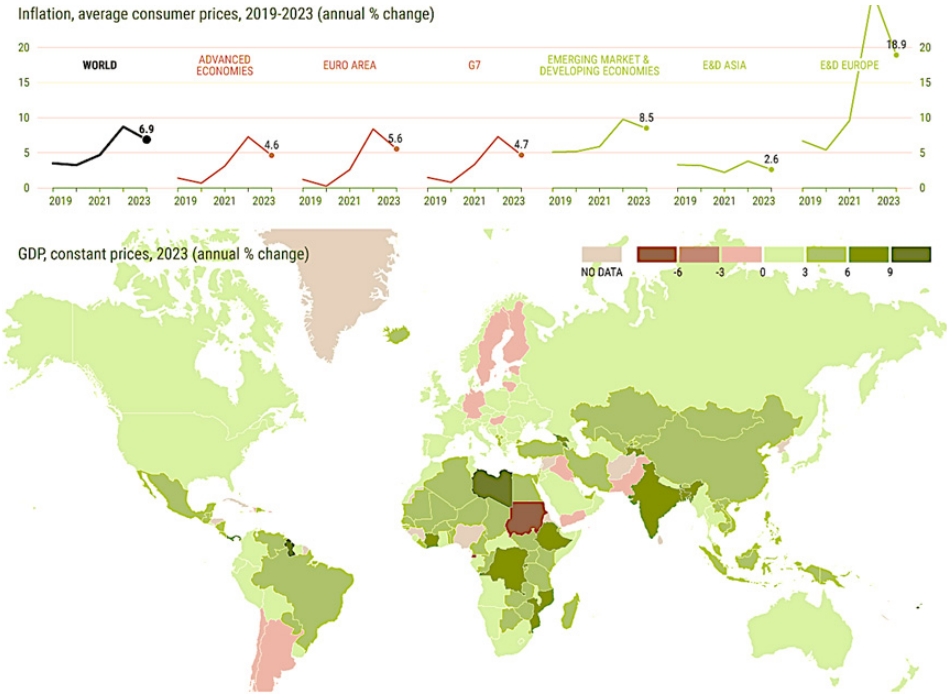
In the long term, trade fragmentation alone – splitting countries into blocs that trade exclusively with each other – could reduce annual global GDP up to 7 per cent⁷. Increasing geoeconomic fragmentation will also hinder multilateral cooperation in delivering critical public goods, such as combating climate change and future pandemics, and ensuring socio-economic security.

⁶ The World Bank. Global economic prospects. January 30, 2024. URL: <https://thedocs.worldbank.org/en/doc/661f109500bf58fa36a4a46eeace6786-0050012024/related/GEP-Jan-2024-Chapter-1-Highlights.pdf>

⁷ Shekhar Aiyar, Chen Jiaqian, Christian Ebeke, Roberto Garcia-Saltos, Tryggvi Gudmundsson, Anna Ilyina, Alvar Kangur, and others. 2023. Geoeconomic Fragmentation and the Future of Multilateralism. IMF Staff Discussion Note 23/001, International Monetary Fund, Washington, DC. <https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/01/11/Geo-Economic-Fragmentation-and-the-Future-of-Multilateralism-527266>

A recent report published by the International Monetary Fund shows that global economic growth in 2023 and 2024 will be significantly slower than the average annual growth rate over the past two decades. It predicts that global GDP growth will be 3 per cent in 2023 and 2.9 per cent in 2024 lower than the average growth rate of 3.8 per cent observed from 2000 to 2019⁸. Annual GDP growth across OECD countries is expected to be below the trend in 2023 and 2024, but to gradually pick up in 2024 as inflation eases and real income rises. While food and service prices continue to rise rapidly, headline inflation has fallen in most economies in recent months as energy prices fall. Core inflation remains elevated (Figure 3).

FIGURE 3. Global economic trends, 2023



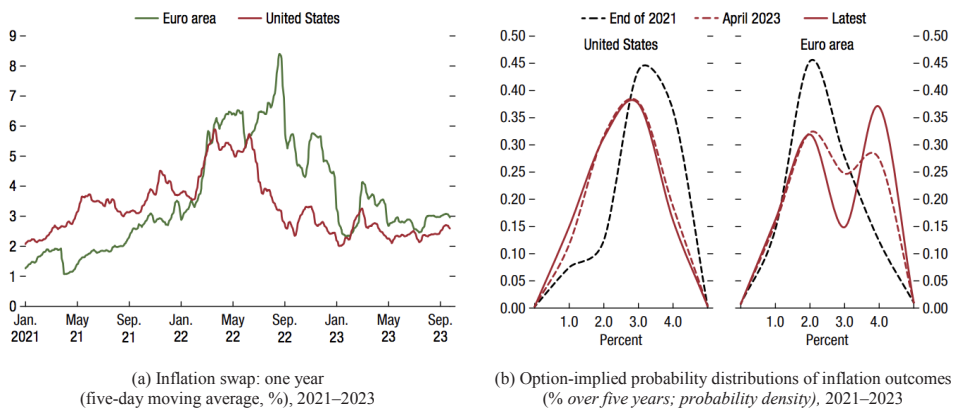
Source: Author's analysis based on ⁹.

8 Geopolitical Futures. Global Economic Trends, 2023. Economic growth will be slow and uneven. October 23, 2023. URL: <https://geopoliticalfutures.com/global-economic-trends-2023/>

9 Geopolitical Futures. Global Economic Trends, 2023. Economic growth will be slow and uneven. October 23, 2023. URL: <https://geopoliticalfutures.com/global-economic-trends-2023/>.

At the same time, inflation is expected to decline this year and next as many countries around the world tighten their monetary policies; however, it will remain elevated. Although core inflation remains high in many countries, the optimistic outlook is consistent with the assumptions about a gradual slowdown in aggregate demand, an easing of labour market tensions, and an easing of price pressures (Figure 4a). Nonetheless, the outlook for inflation remains extremely uncertain. Despite the gradual decline, core inflation remains high, and price pressures are likely to persist longer than financial markets currently price in, leaving the global economy vulnerable to inflationary shocks, such as the expected spikes in food and energy prices over the next five years (Figure 4 a and b).

FIGURE 4 (A, B). Market-based inflation expectations



Source: Author's analysis based on ¹⁰.

Overall, global economic growth will be slow and uneven as it continues to recover from the pandemic, Russia's invasion of Ukraine, and rising global commodity prices (Table 1).

¹⁰ Soft landing or abrupt awakening? Global Financial Stability Report, Chapter 1. October 2023. URL: <https://www.imf.org/-/media/Files/Publications/GFSR/2023/October/English/ch1.ashx>

TABLE 1. World Bank commodity price forecasts

COMMODITY INDEXES (IN NOMINAL US DOLLARS, 2010=100)	2021	2022	2023F	2024F	2025F
Energy	95.4	152.6	108.6	103.7	103.0
Non-Energy	112.5	124.4	111.5	108.0	107.8
Agriculture	108.3	122.7	113.9	112.2	109.7
Beverages	93.5	106.3	106.3	100.9	100.4
Food	121.8	143.7	131.1	129.1	124.7
Oils and meals	127.1	145.2	120.4	117.3	114.1
Grains	123.8	150.4	133.4	129.6	122.9
Other food	113.1	135.6	142.9	144.1	140.3
Raw materials	82.9	80.3	76.0	76.9	78.1
Timber	90.4	80.1	79.9	81.2	82.5
Other raw materials	74.8	80.5	71.8	72.2	73.2
Fertilisers	152.3	235.7	156.5	132.4	119.5
Metals and minerals 3	116.4	115.0	101.4	96.6	102.6
Base metals	117.7	122.4	107.8	102.3	110.5
Precious metals	140.2	136.8	138.4	145.1	131.5
Total	101.0	143.3	109.6	105.1	104.6

Source: formed by author based on ¹¹

¹¹ Conflict in Middle East Could Bring 'Dual Shock' to Global Commodity Markets. The World Bank Press Release. October 30, 2023. <https://www.worldbank.org/en/news/press-release/2023/10/26/commodity-markets-outlook-october-2023-press-release>

Overall, oil prices have risen about 6 per cent since the conflict began. Prices for agricultural raw materials, most metals, and other raw materials were little changed. Overall, commodity prices are expected to fall 4.1 per cent next year. Agricultural prices are expected to fall next year as supplies increase. Base metal prices are also expected to fall by 5 per cent in 2024.

Commodity prices have become more volatile in the face of climate and geopolitical shocks. The war in Ukraine and geopolitical tensions elsewhere could worsen, leading to supply chain disruptions and renewed volatility in the prices of food, fuel, fertilisers, and other raw materials. The suspension of the Black Sea food programme in July and recent attacks on Ukrainian food facilities have raised concerns. In this regard, increased export restrictions on agricultural products aimed at lowering domestic prices complicate the supply of raw materials to world markets and may lead to increased volatility in raw material prices. Lower oil supplies lead to higher oil prices, which could lead to lower oil production. Global economic activity will have a negative impact on global economic activity and increase inflation, with the extent of the impact varying by region.

Raw material prices are expected to stabilise in 2025. Oil prices are expected to reach an average of \$90 a barrel this quarter before falling to an average of \$81 a barrel next year as – according to the Bank’s baseline forecast – global economic growth slows down. Energy transition minerals market continues to expand due to increased demand; prices have doubled in the last five years and will reach \$320 billion in 2022 (Figure 5 and 6).

If the conflict escalates, the outlook for commodity prices will deteriorate rapidly, which suggests that uncertainty will remain for years to come. Despite positive signs

FIGURE 5. Price indexes for selected minerals

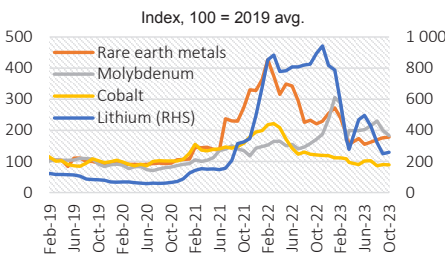
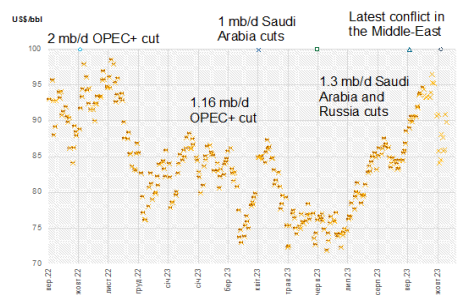


FIGURE 6. Daily Brent prices and important events

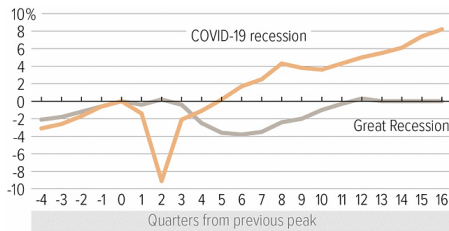


Source: Author’s analysis based on ¹².

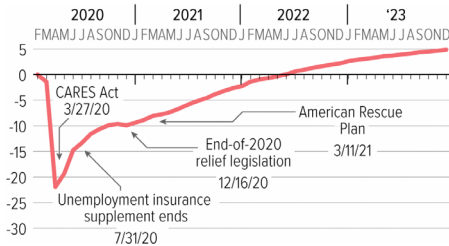
12 John Baffes, Peter Nagle. Commodity Markets: Evolution, Challenges, and Policies. The World Bank. 2023. URL: <https://www.worldbank.org/en/research/publication/commodity-markets>

in some countries and sectors, continued military conflicts and logistic disruptions threaten to undermine unsustainable recoveries in many countries. IMF forecasts also indicate that countries are likely to continue with current social and economic policies to restore economies to pre-pandemic levels (Figure 7 (a-f)).

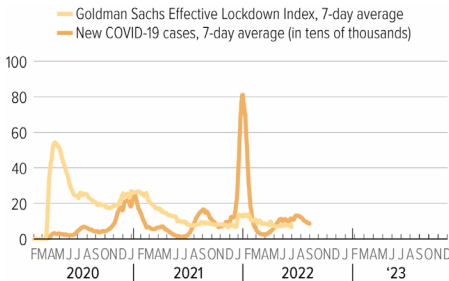
FIGURE 7 (A-F). Dynamics of the socio-economic indexes in recession and the recovery of the world economy, 2023



(a) Change in real gross domestic product from previous peak



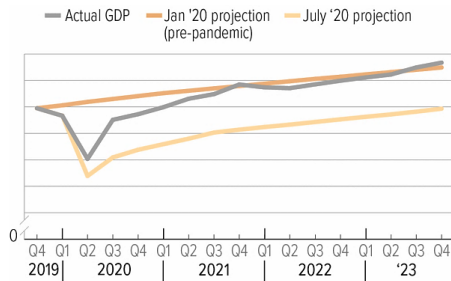
(c) Change in payroll employment since February 2020 in millions of jobs



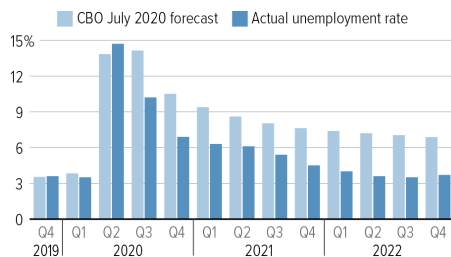
(e) Effective lockdown index and 7-days average of new COVID-19 cases

	Dec. 2020	Jun. 2021	Dec. 2021
Parental caregiving responsibilities	-0.4	-0.4	-0.4
Non-parental caregiving responsibilities	-0.4	-0.1	-0.1
Retirement (expected)	-0.5	-0.7	-0.6
Retirement (unexpected)	-0.3	-0.4	-0.6
Other	-0.3	0.1	

(b) Contributions to change from February 2020 rate in percentage points



(d) Gross domestic product in trillions of 2017 dollars



(f) Unemployment rate for individuals aged 16 years and older, seasonally adjusted

Source: Author's analysis based on ¹³.

¹³ Chart Book: Tracking the Recovery From the Pandemic Recession. The Center on Budget and Policy Priorities (CBPP) 2024. URL: <https://www.cbpp.org/research/economy/tracking-the-recovery-from-the-pandemic-recession>

The economic effects of COVID-19 and the conflict in Ukraine have led to an increase in inflation, a rapid re-normalisation of monetary policies, and the start of a low growth and low investment era. Governments and central banks could experience inflation that is resistant to change over the next two years. This is particularly true given the potential for a longstanding war in Ukraine, the presence of a pandemic that is still not resolved, and economic warfare that causes supply chain separation.

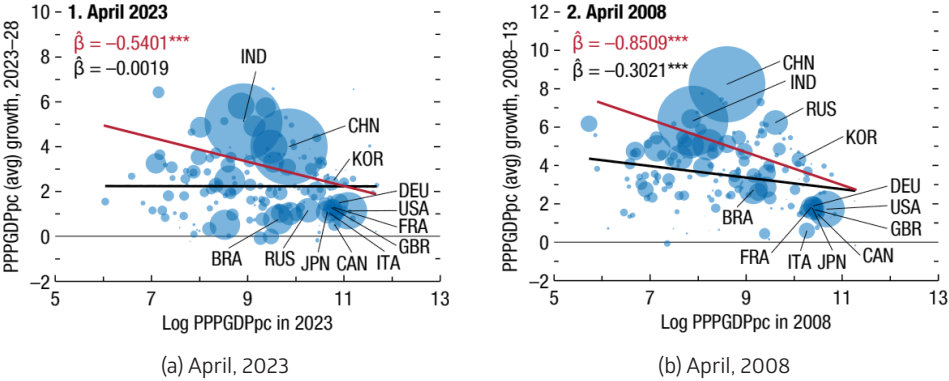
Other economic risks are also significant. A misbalance between monetary and fiscal policies will increase the probability of liquidity crises, which will lead to a longer economic downturn and greater debt stress globally. Continued inflation that is driven by supply will lead to the severe social and economic effects, given the unprecedented combination of social changes in the functioning of the world economy.

2.2. Increasing social crises in the isolation of the global economy and the geopolitical tension

The increasing isolation of the global economy and the geopolitical tension can lead to widespread social crises in the next decade. Even if some regions have experienced a less expected economic downturn, the effects that occur knock-on are most felt by the vulnerable parts of the society and the already-fragile states; they contribute to increased poverty, hunger, violent behaviour, political instability, and even state failure.

At this point, it should be expected that the progress of economies in terms of increasing their living standards and the associated decrease in the rate of change will be reflected in a decrease in the global growth over time. As a result, IMF believes that as much as 0.4 per cent of the afore-mentioned drop in *per capita* global growth potential since 2008 may be attributed to income convergence. Conversely, the five year-ahead growth WEO estimates of April 2023 suggest a rate of 0.5 per cent a year, which is comparable to the 0.5 per cent a year relationship (Figure 8 (a and b)).

FIGURE 8 (A, B). Medium-term growth and income convergence, 2008, 2023



Source: Author’s analysis based on IMF staff calculations:14.

Note: Absolute β convergence specification is $100 \times (\log(\text{GDPpc}\{i,t+5\}) - \log(\text{GDPpc}\{it\})) / 5 = \alpha\{it\} + \beta\{it\} \log(\text{GDPpc}\{it\}) + \epsilon\{it\}$. The size of the bubbles is proportional to the population in year t . The red line is representative of population-based regression. On the vertical axis, the average growth rate of the PPPGDpC is in per cent. The data labels in the figure utilise the ISO country codes that are associated with the United States. PPPGDpC = The average income of a person in a given country in terms of purchasing power

These predictions indicate that the necessary number of years needed to close the gap in income *per capita* between emerging markets and developed countries has increased significantly.

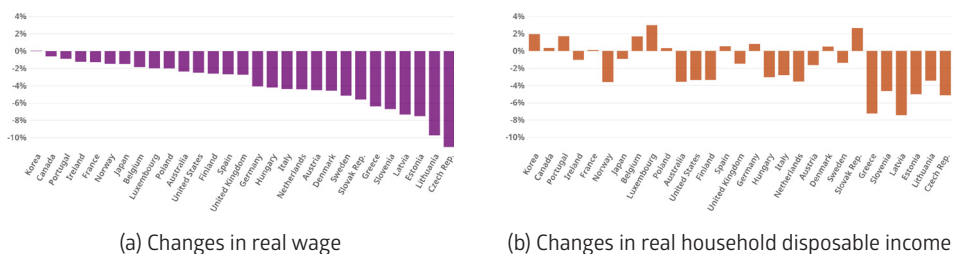
Those factors will also lead to a decline in the middle-income households’ income, which will bring unrest, political differentiation, and requests for increased social assistance in the countries of the world. A combination of high inflation and modest wage growth will lead to a fall in real wages in 2022. In 2023, real wages are expected to stop falling in most OECD countries (Figure 9 (a and b)).

Rising wages, continued employment growth and further moderation in inflation are expected to boost household purchasing power and stimulate consumption in 2024 and 2025. At the same time, after rising in 2023, the savings rate is expected to basically stabilise at a level slightly above the pre-pandemic average, offsetting the impact of a strong recovery in consumption. Many governments have introduced a wide range of support measures to cushion the impact of high energy and food prices on households. Governments will continue to have

14 International Monetary Fund. Global prospects and policies. World Economic Outlook, Chapter 1. October 2023. URL: <https://www.imf.org//media/Files/Publications/WEO/2023/October/English/ch1.ashx>

a difficult balancing act to accomplish between protecting a large portion of their citizens from a long-term cost of living crisis while also paying back the debt.

FIGURE 9 (A, B): Changes in the real wage and real household disposable income (per cent, 2022/2021)



Source: Author's analysis based on ¹⁵.

Higher interest rate levels increase the opportunity cost of consumption, while increased consumer uncertainty creates a higher incentive to save for precautionary reasons. Furthermore, any remaining excess pandemic-related savings are not expected to stimulate the economy further as these savings are increasingly invested in less liquid assets and continue to be held by higher-income households with a lower propensity to spend¹⁶.

High inflation and market volatility affect the cost of living around the world, changing our purchasing power and living standards. The cost of living is the most significant risk to humanity and is considered the most severe international threat in the next two years. This crisis is particularly severe in the short term.

A high cost of living affects the quality of life in many ways. For people on the lower end of the economic scale, such as low-income earners or retirees on fixed incomes, the high cost of living can make it difficult to keep up with the cost of necessities, such as housing, utilities, food, clothing, and transport.

¹⁵ OECD Economic Outlook. A long unwinding road. June 2023. URL: <https://www.oecd.org/economic-outlook/june-2023/#wages-income>

¹⁶ European Commission. Economic and Financial Affairs. Autumn 2023 Economic Forecast: A modest recovery ahead after a challenging year. URL: https://economy-finance.ec.europa.eu/economic-forecast-and-surveys/economic-forecasts/autumn-2023-economic-forecast-modest-recovery-ahead-after-challenging-year_en#executive-summary

Although middle- and high-income people are fortunate enough to be able to meet basic necessities without worry, they still have less funds left for savings, vacations, children’s education, and retirement. A high cost of living can also make a country less attractive to holidaymakers and expats who get less for their money than elsewhere.

Many of the countries with the highest cost of living fall into one of two categories. These are either exotic resorts like Monaco, Cayman Islands, and Bermuda, or Nordic resorts like Switzerland, Iceland, and Norway. The British-controlled island territory of Bermuda was the most expensive place to live in two of the three surveys, with Numbeo score of 133.6 (the third survey did not consider Bermuda). Hamilton, the capital of Bermuda, is considered one of the most expensive cities in the world, with a 900 square meter apartment selling for \$4,058 per month (Table 9)¹⁷.

TABLE 9. Cost of Living Index by country, 2024

RANK	CITY	COST OF LIVING INDEX	RENT INDEX	COST OF LIVING PLUS RENT INDEX	GRO-CERIES INDEX	RESTAU-RANT PRICE INDEX	LOCAL PURCHASING POWER INDEX
1	Bermuda	133.6	91.4	113.6	143.6	124.2	84.3
2	Switzerland	112.2	52.8	84.0	116.7	104.1	118.9
3	Cayman Islands	111.7	76.0	94.8	109.0	99.5	73.7
4	US Virgin Islands	102.6	47.9	76.7	104.1	83.5	55.8
5	Bahamas	88.5	41.8	66.3	80.5	80.4	38.0
6	Iceland	85.7	41.0	64.5	86.5	88.0	109.1
7	Singapore	81.9	71.9	77.1	75.0	55.3	103.0
8	Barbados	79.4	19.9	51.2	78.6	71.8	34.4

¹⁷ Numbeo. Cost of Living Index by Country 2024. URL https://www.numbeo.com/cost-of-living/rankings_by_country.jsp?title=2024

RANK	CITY	COST OF LIVING INDEX	RENT INDEX	COST OF LIVING PLUS RENT INDEX	GRO-CERIES INDEX	RESTAU-RANT PRICE INDEX	LOCAL PURCHASING POWER INDEX
9	Norway	79.2	27.8	54.8	77.5	75.9	94.9
10	Denmark	75.2	28.6	53.1	65.0	82.6	103.
74	Poland	41.9	19.2	31.1	35.9	35.7	66.2
125	Ukraine	28.6	8.5	19.0	26.6	22.2	32.2
138	Madagascar	25.2	8.0	17.0	23.6	13.7	12.3
139	Syria	25.0	4.1	15.1	23.5	16.5	4.7
140	Bangladesh	24.9	2.7	14.4	26.6	14.0	25.8
141	Kenya	24.8	7.1	16.4	23.8	18.3	30.6
142	Afghanistan	22.8	2.8	13.3	17.3	13.0	22.4
143	India	22.2	6.2	14.6	23.5	15.6	60.7
144	Libya	21.2	4.4	13.3	21.5	15.2	33.7
145	Nigeria	19.3	15.4	17.4	21.4	13.3	9.4
146	Pakistan	18.5	2.9	11.1	16.4	12.7	24.5

Source: Author's analysis based on ¹⁸.

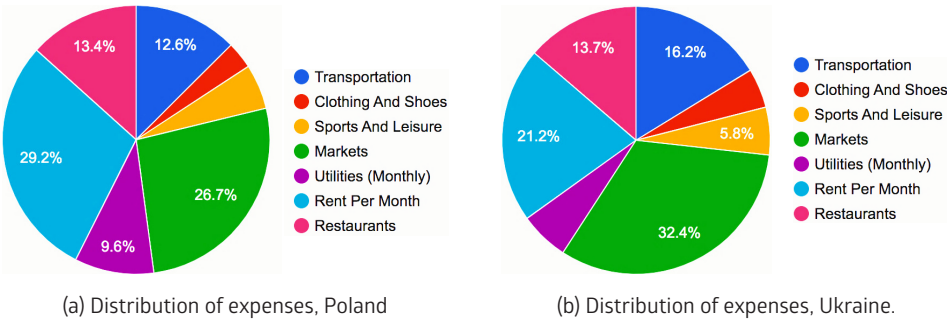
Two other consistently expensive countries are Switzerland, with food prices among the highest in the EU, and Iceland, whose remote location (and associated transport costs) makes consumer goods much more expensive than in continental Europe. However, Iceland has many advantages that offset its high cost of living, one of which is regularly ranked as the safest country in the world. When it comes to benefits, Norway makes two of those lists, but the ratings do not tell the whole story. Wages are high in Norway and the income gap is much smaller

¹⁸ The same.

than in the United States. People in services, education, and public sector earn a living. Additionally, Norway has a very progressive tax system, levying some of the highest taxes in the world but providing its citizens with free universal healthcare and free university¹⁹.

The cost of living in Poland is characterised by such tendencies: the monthly costs for a family of four are estimated at €89,255.1 (PLN 9,438.4), excluding rent. The estimated monthly cost for one person is €27,068.7 (PLN 2,862.4), excluding rent. At the same time, the cost of living in Poland is on average 48.7 per cent higher than in Ukraine and rents in Poland are on average 127.6 per cent higher than in Ukraine (Figure 10 (a and b)).

FIGURE 10 (A, B) Distribution of expenses using Numbeo statistical model (Poland, Ukraine), 2024



Source: Author's analysis based on^{20, 21}.

In Ukraine, for the comparison, the monthly cost for a family of four is estimated to be €58,145.3 (excluding rent), the estimated monthly cost for a single person is €16,831.0 (excluding rent). The cost of living in Ukraine is on average 61.4 per cent lower than in the United States and rents in Ukraine were on average 81.1 per cent lower than in the United States (Figure 9 b).

19 World Population Review. Most Expensive Countries to Live in 2024 URL: <https://worldpopulationreview.com/country-rankings/most-expensive-countries-to-live-in>

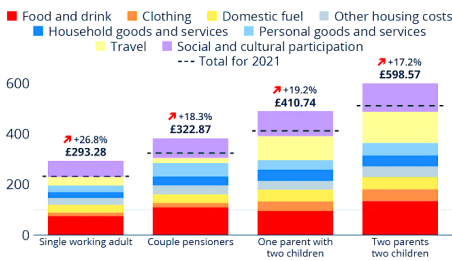
20 Numbeo. Cost of Living in Poland. 2024. URL: https://www.numbeo.com/cost-of-living/country_result.jsp?country=Poland

21 Numbeo. Cost of Living in Ukraine. 2024. URL: https://www.numbeo.com/cost-of-living/country_result.jsp?country=Ukraine

Rising energy prices and inflation, combined with income not rising at the same rate, means millions of people in the world requiring appropriate standards of living. For example, the extent of inflation in the UK revealed that a single working adult living in the UK would need to earn at least £293.28 per week to meet the minimum standard of living. This has increased by 26.8 per cent since 2021, when adults needed an average of £ 231.33 per week (Figure 11; 12).

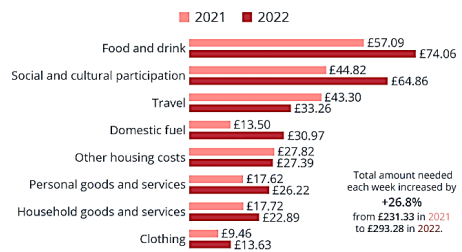
Figure 10 shows how much the average office worker is likely to spend each week on groceries, clothing, transport, social activities, and household items. The cost of social and cultural events has also increased by approximately 45 per cent. The cost of living a simple lifestyle has increased by about 20 per cent for all selected groups and by nearly 20 per cent for a single working adult. A single working adult will need to earn at least £25,000 a year by 2022 to achieve an acceptable minimum standard of living, while a couple with two children will need to earn a total of £43,400.

FIGURE 11. Amount needed each week to reach minimum standard of living in the UK, 2022



Source: Author's analysis based on ²².

FIGURE 12. Amount needed each week for a single working adult to reach the minimum standard of living in UK, 2022



Source: Author's analysis based on ²³.

The Global Risks Report 2023²⁴ shows that global risk experts and executives surveyed the lack confidence in the world's prospects. Less than 16 per cent

²² Anna Fleck. The Rising Cost of Living Is Hitting All Groups. Statista. Sep 15, 2022, URL: <https://www.statista.com/chart/28259/cost-of-living-crisis-impacts-in-uk/>

²³ Anna Fleck. A Breakdown of the Rising Cost of Living. Statista. Sep 15, 2022, URL: <https://www.statista.com/chart/28262/breakdown-of-the-rising-cost-of-living-in-the-uk/>

²⁴ Global risks report 2023. World Economic Forum. (2023). URL: <https://www.weforum.org/publications/global-risks-report-2023/>

were “optimistic” or “positive”. The vast majority (84.2 per cent) expressed “care” or “concern.” By comparison, only 11 per cent are optimistic that the global recovery will accelerate. The erosion of social cohesion, existential crises, and worsening mental health appear to be most severe in the wake of the pandemic amid Russia’s war against Ukraine. The consensus expectation among experts and executives in the report is that the next three years will be characterised by continued volatility and numerous unexpected or developmental disruptions. Other areas most affected were “deterioration in mental health” and “livelihood crisis”.

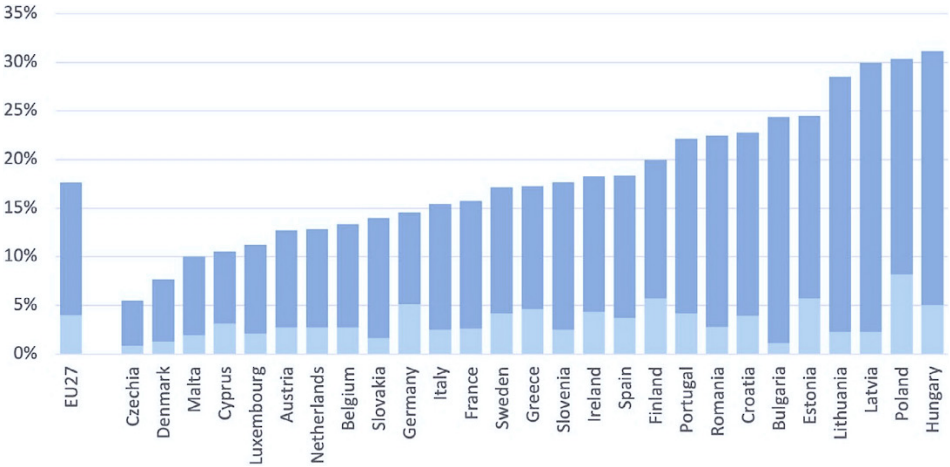
Even before the COVID-19 pandemic, one in six people in the EU suffered from mental health problems, costing them 4 per cent of GDP. The COVID-19 pandemic has exacerbated this situation, with long-term consequences for mental health, particularly for vulnerable groups, such as children, young people, the elderly, and people with underlying health conditions. Children and teenagers worry about climate change, leading to more fear and despair. Russia’s aggression in Ukraine, coupled with the rising cost of living, has made an already difficult situation even worse.

In a recent Eurofound survey, respondents were asked whether they currently have an unmet healthcare need and, if so, what type of care, including mental health care. At the EU level, the overall proportion of respondents reporting unmet health care needs was 18 per cent; specifically for mental health care, the unmet needs amounted to 4 per cent. Respondents to the survey included Estonia, Finland, and Poland – countries with high levels of unmet mental health care needs (Figure 13).

A recent Eurobarometer survey found that the proportion of respondents rating the quality of mental health services as “poor” across the EU in 2023 was 7 per cent. In this case, strong health systems with strong detection, prevention, and response capabilities are critical to preventing and mitigating public health crises and promoting healthy societies.

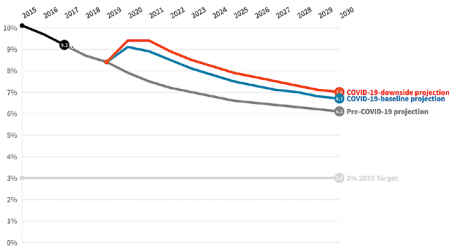
Clearly, the erosion of social cohesion is also seen as the most potentially damaging factor in the coming decade. Thirty-one of 124 countries surveyed ranked it among their top ten near-term threats. It is known that inequality is pervasive in society, whether economic, political, technological, or generational. However, according to World Bank projections, by 2021, 20 per cent of the world’s population will have to recoup their losses, while the poorest 20 per cent will have to lose another 5 per cent of their income. This trend will only continue, and by 2030, 51 million people will be living in extreme poverty (Figure 14 and 15).

FIGURE 13. Unmet mental health needs and the quality of mental health services in the EU, 2022



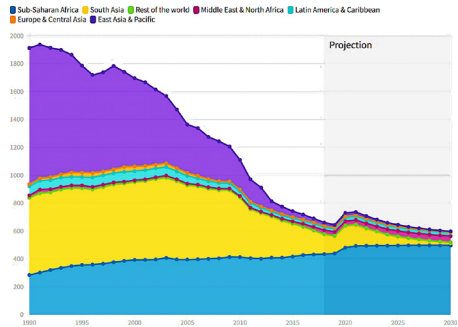
Source: Author's analysis based on ²⁵.

FIGURE 14. Projection of global extreme poverty (per cent), up to 2030



Source: Author's analysis based on ²⁶.

FIGURE 15. Number of extreme poor (millions) by region, 1990–2030



²⁵ European Commission. State of Health in the EU. Synthesis Report 2023. Luxembourg: Publications Office of the European Union, 2023. URL: https://health.ec.europa.eu/system/files/2023-12/state_2023_synthesis-report_en.pdf

²⁶ Nishant Yonzan, Christoph Lakner, Daniel Gerszon Mahler. Projecting global extreme poverty up to 2030: How close are we to World Bank's 3% goal? World Bank Blogs. October 09, 2020. URL: <https://blogs.worldbank.org/opendata/projecting-global-extreme-poverty-2030-how-close-are-we-world-banks-3-goal>

Descriptions of the intensity and frequency of poverty in 110 developing countries show a worrying upward trend – the higher the frequency of poverty, the greater the extent to which the poor suffer (Figure 16). According to global MPI values, the poorest countries tend to have the highest incidence and highest intensity. For example, in the Central African Republic (2018/2019) and Chad (2019), more than 80 per cent of the population is poor, and poverty levels are even higher – 57.3 per cent and 61.4 per cent respectively. Some countries are bucking this trend.

FIGURE 16. The higher the incidence of poverty, the higher the intensity of poverty that poor people tend to experience

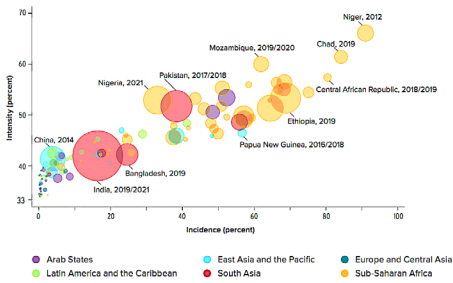
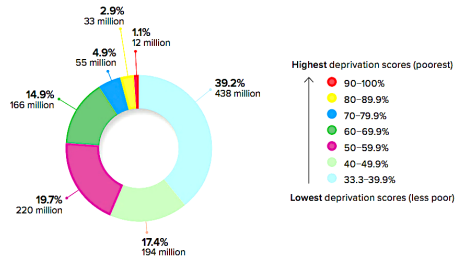


FIGURE 17. More than two-fifths of poor people experience severe poverty



Source: Author's analysis based on ²⁷.

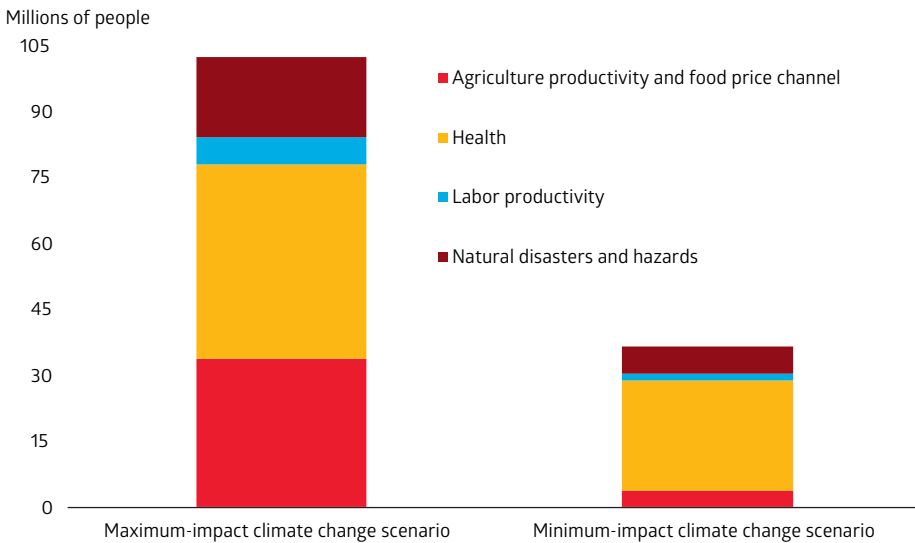
For example, Papua New Guinea has low intensity (46.5 per cent) and low incidence (56.6 per cent) compared to other countries. Of 1.1 billion people living in poverty, 438 million people (39.2 per cent) have a lower poverty score of 33.3–39.9 per cent, close to the poverty line (Figure 17). But 485 million people (43.4 per cent) still suffer from severe poverty, with poverty levels ranging from 50 per cent to 100 per cent. This requires urgent attention to the poorest and their associated poverty.

The potential for increasingly frequent and severe natural disasters due to climate change poses a global threat and could result in significant losses of life,

²⁷ OPHI Oxford Poverty & Human Development Initiative. Global Multidimensional Poverty Index 2023. Unstacking global poverty: Data for high-impact action. URL: <https://hdr.undp.org/system/files/documents/hdp-document/2023mpireportenpdf.pdf>

livelihoods, and production. Over the past three decades, it has affected 130 million people, causing an average of more than 40,000 deaths per year²⁸. Natural disasters can exacerbate poverty in many ways. For example, changes in environmental conditions that exacerbate the spread of disease may lead to worsening health outcomes for low-income families, including increased incidence of stunting in children (Figure 18).

FIGURE 18. Impact of climate change on extreme poverty by 2030



Source: Author's analysis based on ²⁹.

Negative impacts on agricultural output could also lead to higher food prices, which is particularly problematic for poor households who spend most of their income on food. In some countries, poor and vulnerable groups live in informal settlements or may not have access to adequate housing, making them more

²⁸ Ze Song, Gal Hochman, Timilsina, R.Govinda. Natural Disaster, Infrastructure, and Income Distribution: Empirical Evidence from Global Data. The World Bank. Policy Research Working Paper Series 10504, 2023.

²⁹ The World Bank. Global economic prospects. January 30, 2024. URL: <https://thedocs.worldbank.org/en/doc/661f109500bf58fa36a4a46eeace6786-0050012024/related/GEP-Jan-2024-Chapter-1-Highlights.pdf>

vulnerable to extreme weather events, other natural disasters, and related diseases³⁰. All of this is likely to continue as an uneven economic recovery drives up income inequality, ultimately fuelling resentment and polarisation. These phenomena could trigger a resurgence of social unrest as future increases in food and fuel prices³¹ impact economic activity, particularly in countries with higher economic activity but limited capacity to mitigate the effects through political measures³². Social unrest could also negatively impact the implementation of necessary reforms³³.

2.3. Social threats of the long-lasting Russia's military aggression against Ukraine in the economic security of the partner countries

In order to ensure the development of the welfare economy, cope with the new challenges brought by the COVID-19 epidemic and Russia's war against Ukraine, promote the comprehensive reconstruction of Ukraine, and improve the quality of life, policy measures of the partner countries are needed. B.M.Jenkins³⁴ estimates that global economic growth in 2022 was expected to be around 5 per cent before Russia invaded Ukraine. The OECD report³⁵ released in November 2022 states that the conflict in Ukraine caused significant and serious disruptions to energy markets. This "shock" was one of the main reasons why economic growth would slow down to only 3.1 per cent in 2022 and 2.2 per cent in 2023. As known,

30 D. Dodman, D. Archer, and D. Satterthwaite. Responding to Climate Change in Contexts of Urban Poverty and Informality. *International Institute for Environment and Development* 31(1): 3-368. 2019.

31 Philip Barrett, Maximiliano Appendino, Kate Nguyen, and Jorge de Lion Miranda. Measuring Social Unrest Using Media Reports. *Journal of Development Economics*. 158: 102924. September, 2021. URL: <https://doi.org/10.1016/j.jdeveco.2022.102924>.

32 Metodij Hadzi-Vaskov, Samuel Pienknagura, and Luca Antonio Ricci. The Macroeconomic Impact of Social Unrest. IMF Working Paper 21/135, International Monetary Fund, Washington, DC. 2021. <https://www.imf.org/en/Publications/WP/Issues/2021/05/07/The-Macroeconomic-Impact-of-Social-Unrest-50338>

33 International Monetary Fund. Global prospects and policies. *World Economic Outlook*, Chapter 1. October 2023. URL: <https://www.imf.org//media/Files/Publications/WEO/2023/October/English/ch1.ashx>

34 Brian Michael Jenkins. Consequences of the war in Ukraine: The economic fallout. RAND Corporation. March 7. 2023 URL: <https://www.rand.org/blog/2023/03/consequences-of-the-war-in-ukraine-the-economic-fallout.html>

35 Organisation for Economic Co-operation and Development (OECD). Russia's war of aggression against Ukraine continues to create serious headwinds for global economy. 2022. URL: <https://www.oecd.org/newsroom/russia-s-war-of-aggression-against-ukraine-continues-to-create-serious-headwinds-for-global-economy.htm>

the war has had the most profound impact on the European economy, which was expected to grow by only 0.3 per cent in 2023. Nonetheless, the EU countries and other countries around the world continue to provide financial, humanitarian and military support to Ukraine.

The largest contributors to the Ukrainian state budget are the United States, the European Union, Germany, Canada, and the United Kingdom. As of early November, aid from these countries accounted for one-third of Ukraine's 2022 consolidated budget spending. A total of 16 EU countries are on the list. In 2023, Poland, Estonia, Latvia, the United States, and Lithuania topped the updated Forbes Friends of Ukraine rankings. From the beginning of Russia's full-scale offensive to August 3, Ukraine received international aid worth EUR 84 billion. Among them, EUR 39 billion are used for military aid, EUR 32 billion are used for financial support, and EUR 13 billion are used for humanitarian aid. Another EUR 10 billion will be used to provide housing for displaced people. Those providing the most extensive aid are the United States – EUR 44.5 billion, Germany – EUR 7.6 billion, the United Kingdom – EUR 6.6 billion, Italy – EUR 2.8 billion, Lithuania – EUR 500 million, and Estonia – EUR 300 million. Poland, which has provided aid worth EUR 5.1 billion, surpasses France, Canada, Italy, and Spain on this indicator. As for the country's foreign aid ratio to GDP, the most generous is Estonia, accounting for 1.13 per cent of GDP, Latvia 1.03 per cent, and Poland 0.88 per cent. Among them, Lithuania accounts for 0.55 per cent of GDP, the United Kingdom accounts for 0.25 per cent, and Italy accounts for 0.15 per cent³⁶. In fact, supporting economic growth in the face of rapid and alarming global challenges has been proven practical. The scientific and expert communities emphasise the need for Ukraine to accelerate its recovery and for countries around the world to provide unconditional support to Ukraine. According to the trends in indicators of social changes and increasing global challenges in the context of the Russian war against Ukraine, the analysis of the functional components of the world economic security (social, scientific, and financial components) of partner Euro-Atlantic region countries becomes extremely important.

Ukraine's postwar reconstruction will be based on its competitive economy, civil society, and welfare state. Under war conditions, it became extremely difficult to maintain social standards and solve rapidly emerging social problems. The main feature of a competitive economy is the country's ability to form a workforce of appropriate

36 Ukraine Recovery Conference. London. 21-22 June 2023. URL: <https://ua.urc-international.com/>

quality and efficiency based on an educational and scientific environment. In 2014, when Ukraine faced mixed threats and risks, unemployment began to rise, reaching 9.8 per cent in early 2022 (unemployment in Poland was 3.4 per cent, in the United States – 3.7 per cent, and in Estonia – 6.2 per cent) (Figure 19).

FIGURE 19. Social component indicators of the economic security of the partner countries in Euro-Atlantic zone, (1991–2021)

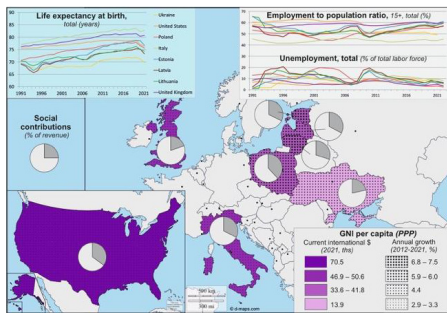
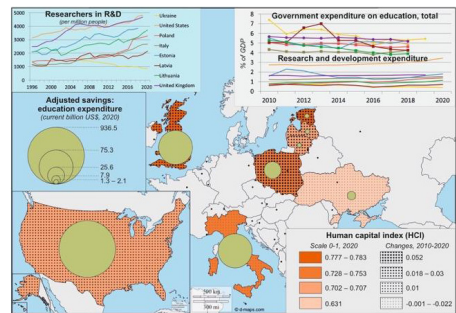


FIGURE 20. The education and science component indicators of the economic security of the partners countries in Euro-Atlantic zone, (1991–2021)



Source: Author’s analysis and calculations.

The pre-war period in the social and scientific development of the Euro-Atlantic partner countries can be measured by the following economic security indicators:

- 1) *Adjusted savings.* Adjusted savings: Before the war, Ukrainians had saved approximately \$7.9 billion for education, marking an increase of \$1.5 billion as compared to 2016 – a growth of 83.5 per cent. In comparison, Italy’s savings amounted to \$73.5 billion, and Poland’s to \$25.6 billion.
- 2) *Current education expenditure* (expenditure in public institutions). Education expenditures account for more than 90.0 per cent of the total expenditures of national institutions, and in some years, it is almost 98.0 per cent; the United Kingdom – 97.0 per cent, Italy – 95.0 per cent (Figure 20).
- 3) *Government expenditure on education.* Ukraine’s education expenditures account for 6.0 per cent of GDP (in pre-war period, it was more than 8.0 per cent of GDP), which exceeds the values of many highly developed countries (the proportion of public GDP expenditure has been higher in recent years). For comparison, it does not exceed 5.0 per cent in the United States, Italy, and Poland, and it is 6.0 per cent in the United Kingdom, Latvia, and Estonia.

4) *Public procurement plans and education financing on a competitive basis.* Mechanisms for implementing support programmes, attracting international philanthropic aid, and setting up co-investment funds specialised in educational services are becoming increasingly important. Before the large-scale military invasion, the value of the international aid was 18.6 per cent, over two times higher than in Italy.

5) *Human capital index.* Growth in the human capital index (at the beginning of 2021, Ukraine's index was 0.63 compared with 0.79 in the United Kingdom, 0.79 in Estonia and 0.75 in Poland.

6) *Research and development expenditure.* Insufficient R&D financing at the beginning of 2021 led to the increasing threats of economic security. Ukraine's R&D expenditure accounted to 0.4 per cent of GDP, over eight times lower than the expenditure in the United States, four times lower than in the United Kingdom and Estonia, and three times lower than in Italy and Poland.

7) *Employment in the field of R&D.* Employment in the field of R&D in Ukraine has declined. At the beginning of 2021, there were 846 researchers per million people – 4.4 times that of Lithuania, 3.9 times that of Poland, and 3.2 times that of Poland.

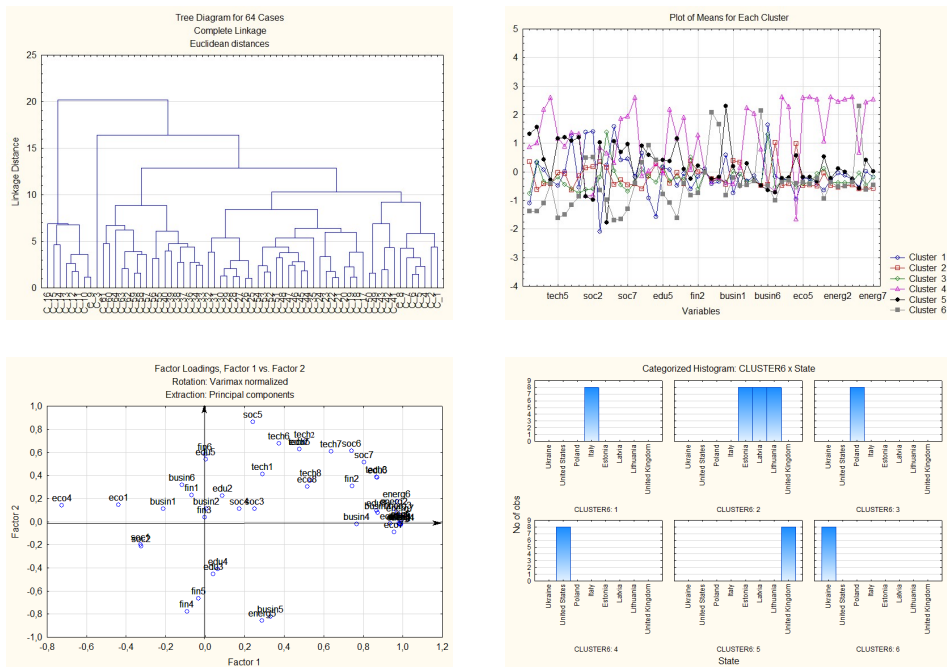
In the pre-war period, specifically in 2021, Ukraine's economic development was marked by a significant increase in foreign direct investment (FDI) net inflows, rising approximately 13-fold over a span of more than 20 years (1991–1994 to 2021). However, this figure was three times higher in Italy and ten times higher in Poland. As of April 2023, Italy's FDI increased by EUR 12.667 billion.

Effective instrument of the economic security in the field of rapid technology and innovation development is the creation of joint ventures, but unlike many European and other countries, this direction is not widespread in Ukraine. At the beginning of 2023, the development of joint entrepreneurship in Ukraine was estimated at 1.8 points, which was the same as before the war. For example, when compared with the United States, the numerical difference is large – at the beginning of 2023, the indicator was 75.5 points, 41.9 times higher than that of Ukraine; the British index was 31.3 times higher (56.3), and Estonia's index was 19.3 times higher (34.8). The experience of many developed countries shows that it is crucial to expand the scope of public-private partnerships in investment and innovation and involve the state in the implementation of advanced innovative technology entrepreneurship projects for the rapid recovery of the economy in the continuing war conditions.

It is important to focus attention on the need to cluster partner countries according to the level of economic security in order to identify the most significant social changes in the partner countries of the Euro-Atlantic zone and the possibility of developing policies to counter risks in the conditions of growing military conflicts

in the world. The study, “Analysis of the energy and environmental development components of the world economic security of the United Euro-Atlantic countries and Ukraine”³⁷, carried out a detailed analysis of 50 indicators in terms of 7 components (technological and innovative, social, educational and scientific, financial, business-environment, environmental, and energy) of the economic security.

FIGURE 21. Graph-tree of indicators of the economic security (1991–2021) including social, educational and science components; a plot of the means for each cluster and a visualisation of the distribution of countries by clusters from pre-war period (2001–2021), assuming 6 clusters



Source: Author’s analysis based on ³⁸.

37 Olha Ilyash, Alessandro Rubino, Viktoriia Khaustova, Claudia Capozza, Tetiana Salashenko and Stella Lippolis. Analysis of the energy and environmental development components of the world economic security of the United Euro-Atlantic countries and Ukraine. International Conference on Sustainable, Circular Management, and Environmental Engineering (ISCMEE 2023). Volume 408, 01009. 2 August 2023. URL: <https://doi.org/10.1051/e3sconf/202340801009>

38 The same.

As part of this research, selection of cluster analysis results of the economic security of the mentioned partner countries of Euro-Atlantic zone (Ukraine, Poland, Italy, Estonia, Lithuania, Latvia, the United States, and the United Kingdom) including Social, Education, and Science components of the economic security is conducted. As a result of the analytical study, six clusters were selected, corresponding to link distances from 5 to 10. This allowed to classify countries into 6 groups based on 50 indicators according to similar characteristics of the indicators. Next, it was possible to use separate statistics for each country (Figure 21).

The data in Figure 21 show that, with the exception of the Baltic States, each country forms its own cluster. Through the preliminary processing of social component of the security indicators of the partner countries, the most common object clustering method (Euclidean distance) can be applied, and two cluster analysis methods (hierarchical method and K-means method) can be used to ensure the homogeneity of the indicators. Countries determine the social threats/preferences of the economic security potential in their terms.

Let us examine the distinctive social changes in the system of economic security indicators during the study period to provide economic significance to this clustering, aimed at uniting efforts to address the challenges posed by the war. Tree clustering methods create clusters based on defined distances between objects (indicators). Based on hierarchical cluster analysis, the following stable Euro-Atlantic clusters of social changes were identified:

1. *K1 – Italy* – high-tech products account for a lower proportion of total exports, higher education savings indicators, higher R&D investment indicators per million people, and a higher proportion of medium- and high-tech products; product exports, high life expectancy index, education expenditure ratio is relatively low.

2. *K2 – Estonia, Latvia, Lithuania* – increasing social contributions, GNI *per capita*, low domestic credit to private sector by banks.

3. *K3 – Poland* – high proportion of medium- and high-technology exports, high human capital index, large R&D investment per million people, high social contribution related to labour income, low proportion of education expenditure in GDP, declining energy intensity index.

4. *K4 – United States* – high level of research and development expenditure (% of GDP), high percentage of the government expenditure on education, highest primary energy consumption and *per capita* energy consumption indicators, relatively low growth rate of ICT industry, joint entrepreneurial development.

5. *K5 – United Kingdom* – higher GDP *per capita* indicator at purchasing power parity, highest marine protected areas indicator (% of sea occupied), high

proportion of medium and high technology exports, high life expectancy index, high proportion of relative education expenditure.

2. *K6 – Ukraine* – the proportion of education expenditure in GDP is high, the proportion of own expenditures to support and develop education is high, the savings level of the educated population is high, the ICT industry growth index is moderate, and the GDP per million people R&D investment is negligible, unemployment is high, and the gross national income *per capita* remains at a low level.

There are large differences in the values of social indicators among the components of global economic security that partner countries consider. Clusters therefore highlight differences and similarities in economic growth potential and lead to the formation of separate regional clusters in facing social challenges. This method of distance calculation provides an opportunity to identify closely aligned clusters of like-minded countries within the Euro-Atlantic region, enabling effective collaboration in addressing and combating challenges arising from the Russian war against Ukraine and the growing prevalence of military conflicts worldwide.

It is known that the second issue is the high levels of corruption which have a negative impact on the world economic security. Corruption is one of those problems that cannot be solved in isolation from political, economic, and social problems. The more corrupt a country, the slower it develops economically and socially. In addition, corruption exacerbates poverty and significantly limits the country's ability to fight and further develop in the face of growing global tensions, economic instability, and military challenges.

Thus, attracting investments from other countries may pose a threat to the world's economic security, especially in the conditions of military operations, for example of the war conditions in Ukraine. Furthermore, investment inflows from offshore jurisdictions (nominal variables using a binary approach) may be associated with money laundering and the growth of the underground economy.

The aforementioned considerations focused attention on the selection of the second group of countries of the cluster analysis, which was carried out as part of the preparation of analytical materials for the Ministry of Economy of Ukraine regarding the assessment of losses and damage caused by the Russian war in Ukraine and the unification of the Ramstein group countries for the purpose of economic reconstruction and social support of people affected by the war. The goal was to group the countries of the world according to the impact of investment risk indicators on economic security. The groupings of the partner countries

are based on the 2022 Corruption Perceptions Index³⁹, Transparency international, GDP *per capita* and the country's status (or characteristics) as an offshore jurisdiction as of 2022 (Figure 22 and 23).

FIGURE 22. Scatterplot depicting the relationship between the corruption perception level, GDP *per capita* (USD *per capita*), and characteristics of offshore jurisdiction in the countries of the Ramstein group (as per the 17th meeting on 22 December 2023), 2023

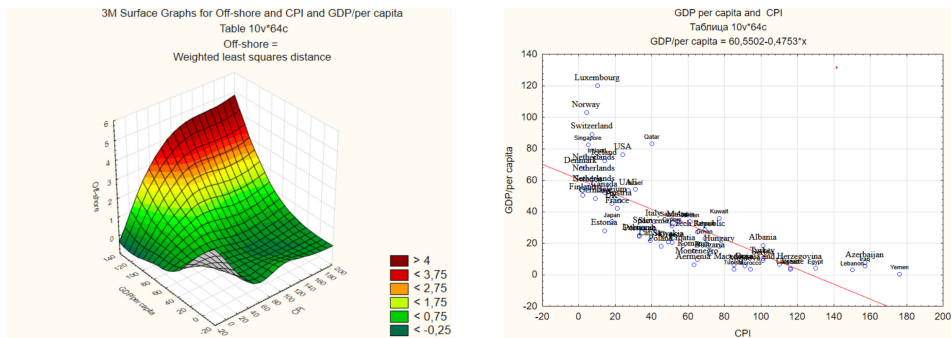


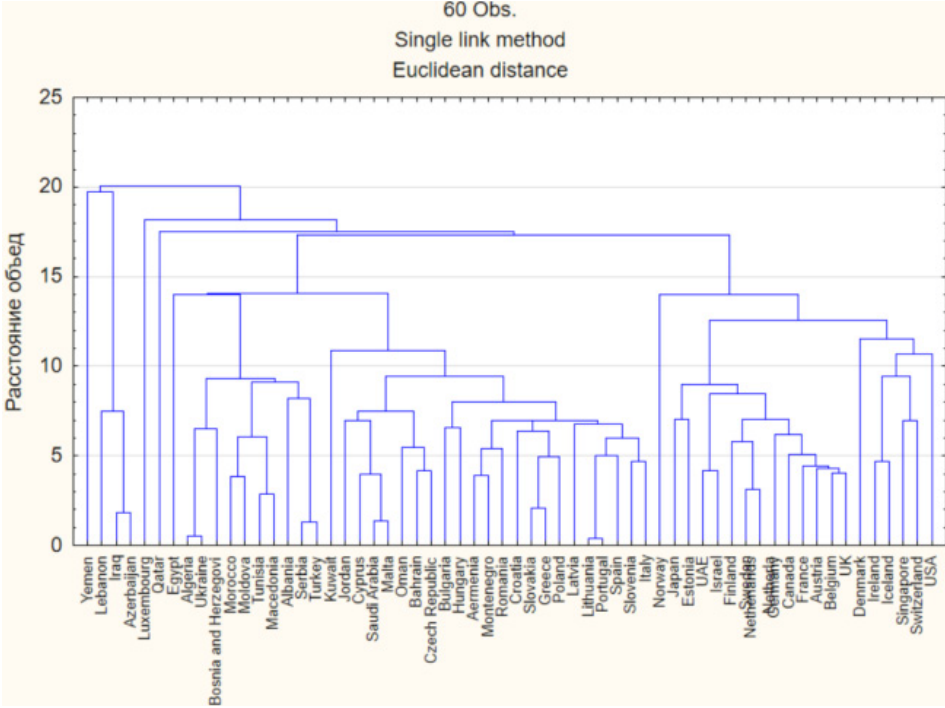
Figure 23 shows that Ukraine belongs to Group 1, *i.e.*, countries with high level of corruption and low level of social development and economic security. However, attracting investment from such countries may exacerbate social corruption. In our view, it is recommended to strengthen investment activities in Groups 2 and 3, with certain reservations for Group 5, through the use of additional control and monitoring instruments (FATF Recommendations and Egmont Group Principles)^{40,41} to combat money laundering, terrorist financing, and the proliferation of weapons of mass destruction.

39 Transparency International. Corruption Perception Index. 2022. URL: https://www.transparency.org/en/cpi/2023?gad_source=1&gclid=CjwKCAiAlcyuBhBnEiwAOGZ2S6eVX7uaynTq121Xx67V0jHDX_W0cnMz4P-1f6037o7UNurxdfRk11RoCj8QAvD_BwE

40 Financial Action Task Force (FATF). The FATF Recommendations. November 2023. URL: <https://www.fatf-gafi.org/en/publications/Fatfrecommendations/Fatf-recommendations.html>

41 The Egmont Group. Egmont Group Of Financial Intelligence Units Principles For Information Exchange Between Financial Intelligence Units. July 2013. URL: <https://egmontgroup.org/wp-content/uploads/2021/09/Egmont-Group-of-Financial-Intelligence-Units-Principles-for-Information-Exchange-Between-Financial-Intelligence-Units.pdf>

FIGURE 23. Graph-tree of country-partner connections within the Ramstein group based on indicators of corruption perception, GDP per capita, and offshore jurisdiction characteristics (dummy variable), 2023



Source: Author's analysis based on the Analytical Report to the Ministry of Economy regarding the RDNA Programme in cooperation with scientific group of prof. Anatoliy Mokiy and prof. Mariya Fleychuk.

Summarising the results of the cluster analysis, as already mentioned, all potential investor countries among the Ramstein Group partners are divided into five groups, and we would like to briefly describe their characteristics (Figure 23): (1) high level of corruption, low level of socio-economic development; (2) moderate corruption and moderate socio-economic development; (3) low degree of corruption and high degree of socio-economic development; (4) highest degree of corruption and lowest degree of socio-economic development; (5) characteristics of offshore jurisdiction and socio-economic development countries.

Conclusions

Based on the research, it is concluded that the COVID-19 crisis and Russia's full-scale invasion of Ukraine have exacerbated social divisions, which can lead to significant regional clashes or widespread global destabilisation. Obviously, the emergence of new global threats the world faced in early 2023 – including the cost-of-living crisis, rising inflation, GDP deficit, declining global investment, significant price increases, trends of de-globalisation, and extremely low economic growth – will lead to regression in human development and scale the social risks of geo-economic fragmentation and convergence in the functioning of the global economy. This geopolitical polarisation of the global economy has already led to the loss of real *per capita* income in emerging and developed economies in the context of ongoing military conflicts.

Russia's war against Ukraine has increased geopolitical tensions and the geopolitical risks of social cohesion. Serious disruptions in oil supplies and a sharp rise in commodity prices, slower economic growth, ongoing military conflicts, disruptions in logistics, and the division of countries into blocs in the global economy threaten to undermine the fragile recovery in many countries, which will hinder international cooperation in the distribution of public goods and negatively affect the social security of developing countries.

This will affect the standard of living and the quality of life of population vulnerable segments in developing countries and, on the other hand, will accelerate the increasing poverty processes, hunger, violent behaviour, and social degradation of society. Disappointing forecasts of a widening *per capita* income gap in countries with different degrees of economic development, declining income of middle-income households, falling real wages, investments in low-liquid assets, and reduced purchasing power will increase social risks and indicate a long-term cost of living crisis.

In this regard, the rising cost of living will leave population vulnerable groups without the most basic means of subsistence (housing, utilities, food, clothing, and transport). The analytical study found that the countries with the highest cost of living include exotic countries (Monaco, Cayman Islands, and Bermuda) and Scandinavian resorts (Switzerland, Iceland, and Norway). At the same time, the social gap between the neighbouring countries of Poland and Ukraine is widening (by half). The 2023 Global Risks Analysis shows that, despite the acceleration of the global recovery, there are growing risks of erosion of social cohesion, deterioration of mental health, and livelihood crises for socially vulnerable groups (children, youth, the elderly, and people with diseases). In addition, people

are often dissatisfied with the quality of psychological health care, particularly in countries such as Estonia, Finland, and Poland.

The growing erosion of social cohesion and the spread of social inequality in society is potentially the greatest social challenge to global security. This is certainly confirmed by the negative forecasts of rising global extreme poverty in the Central African Republic and Chad, for example, and the increase in morbidity in these countries. In addition, the global threat of significant population loss can be explained, for example, by changes in environmental conditions that have led to higher food prices, which are felt by extremely poor households.

It is worth noting that the growing impact of social risks on global economic security increases interstate tensions and requires the unification of world leaders and partner countries to reduce geopolitical pressure and conflicts. The war in Ukraine has become a turning point for Europe and the world in the context of changing the global security architecture. Today, Russia is the main threat to the security of the European Alliance and to the peace and stability in the Euro-Atlantic countries. Therefore, the analysis of the functional components of global economic security (social, scientific, and financial) of the Euro-Atlantic partner countries is of particular importance. The analysis of the pre-war period allowed clustering the partner countries by the level of economic security as well as revealed significant differences in social indicators of economic security. Among the six clusters, Italy (Cluster 1) was singled out as a highly innovative and high-tech country with a high standard of living and life expectancy index. Estonia, Lithuania, and Latvia (Cluster 2) are increasing social contributions and GNI *per capita*. Poland (Cluster 3) demonstrates a high human capital index, and the United States (Cluster 4) has a high level of public spending on education. The United Kingdom (Cluster 5) demonstrates the highest GDP *per capita* at purchasing power parity and a high share of relative spending on education), while Ukraine (Cluster 6), on the contrary, shows an increase in the share of own spending on education support and development as well as a high level of savings of the educated population. The second stage of Ramstein Group country clustering identifies countries with high levels of corruption and low levels of social development and economic security. This is a particularly important stage of the study as it demonstrates the growing social risks of military conflicts in the event of a decline in the fight against money laundering, terrorist financing, and the proliferation of weapons of mass destruction.

As a result, on the one hand, current social problems in the context of ongoing military conflicts can lead to significant regional clashes or large-scale global destabilisation. On the other, these obstacles demonstrate that strengthening

international and security cooperation is essential. In this context, a unique role should be devoted to the development of a new security concept for international security and stability within the framework of the EU-NATO strategic partnership and it requires the unification of world leaders and partner countries to reduce geopolitical pressure and conflicts.

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Mapping the world's changing technological landscape

Alina Landowska

Introduction

Technology, serving as a crucial driver for economic progress and innovation, has its impact reaching far and wide. Despite economic challenges and geopolitical uncertainties, the prospects for the tech industry in 2023 remained largely positive¹. This underscores the enduring resilience of the tech sector as a viable avenue for business growth. Interestingly, the reach of technology, particularly the Internet, varies significantly across different economic strata. In 2022, Internet usage was widespread among more than 90% of the population in high-income countries. In contrast, in economically less privileged countries, Internet access was limited to only a quarter of the population. Furthermore, in 2023, about 33% of the global population, which translates to roughly 2.6 billion people, were still not connected to the Internet². This highlights the digital divide that still exists, underscoring the need for more inclusive access to technology. This digital divide also extends to the realm of emerging technologies, which are reshaping the global power dynamics.

1 <https://www.statista.com/statistics/1356613/future-prospects-of-the-global-tech-industry-by-points/#statisticContainer> (Accessed: January 12, 2024)

2 <https://www.statista.com/statistics/268938/global-it-spending-by-segment/> (Accessed: January 12, 2024)

Emerging technologies have become a crucial force in redistributing power among nations, thereby significantly shaping the dynamics of international relations. This is particularly evident in the technological superiority of advanced economies. Their capacity to innovate and harness cutting-edge technology has resulted in a greater emphasis on high-tech products in their exports. This shift often comes at the expense of traditional industries. There is already a widely acknowledged concept of a “hierarchy” among nations, wherein their exports can be classified along a spectrum of products. For instance, the share of high-tech products in total extra-EU trade increased from 14.7% (8.7 billion) in 2012 to 16.6% (36.1 billion) in 2022³. This trend indicates a greater emphasis on high-tech products in their exports. The impact of artificial intelligence (AI) on international trade patterns is also noteworthy⁴. AI, as an emerging technology, plays a significant role in this shift towards high-tech exports. Meanwhile, traditional industries are experiencing a decline. The UK, for example, has seen the rise and fall of many manufacturing industries, such as cotton, wool, coal, and shipbuilding⁵. This decline in traditional industries is not limited to the UK. Globally, manufacturing sectors are becoming less important for national income⁶. For instance, just in the US between 2002 and 2020, there was a significant drop in revenues for traditional industries. According to The US Census Bureau’s Service Annual Survey, estimated newspaper publishers’ revenue dropped by 52.0%, and estimated revenue for periodical publishing, which includes magazines, fell by 40.5%⁷.

As articulated in the report of the Distinguished Reflection Group on Transatlantic China Policy (Ischinger and Nye Jr, 2021, pp. 28), “Technology is already a key element in the competition between China and the “West” and will be in the future (...)”. China’s 14th Five-Year Plan underscores the significance

3 <https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=375722> (Accessed: January 12, 2024)

4 <https://www.brookings.edu/articles/the-impact-of-artificial-intelligence-on-international-trade/> (Accessed: January 12, 2024)

5 <https://www.economicshelp.org/blog/19037/business/problems-of-declining-industries/> (Accessed: January 12, 2024)

6 However, the biggest change is observed in the United Kingdom, where manufacturing value added as a percentage of GDP decreased from 27.2% in 1980 to 8.6% in 2019 <https://www.statista.com/chart/20148/manufacturing-value-added-as-percent-of-gdp-in-major-economies/> (Accessed: January 12, 2024)

7 <https://www.census.gov/data/tables/2021/econ/services/sas-naics.ht> Mapping the world’s changing technological landscape ml (Accessed: January 12, 2024)

of the country's proficiency in strategically important technologies. The plan identifies several key areas of focus, including "(...) artificial intelligence (AI), quantum information, integrated circuits, life and health, brain science, bioengineering breeding, aerospace technology, deep earth and deep sea, and other pioneering fields (...)" (UNDP, 2021). Both large nations and smaller European states or the European Union view investment in technology as a strategic variable of importance. In this regard, Franke and Torreblanca (2021) emphasise that technological sovereignty becomes crucial for survival in a scenario where state entities dominate the global market, multilateralism is replaced by multipolarity and unilateralism, and dominant powers leverage interdependencies to carve out their spheres of influence. In the global race for technological dominance, both advanced and emerging economies have their unique strengths and challenges. While advanced economies often lead in terms of innovation and technology development, emerging economies can leapfrog certain stages of technological development by adopting and adapting existing technologies. However, the effort of emerging economies to reduce the disparities with developed ones continues to be a complex and intricate matter (Nelson, 1967), particularly given that these disparities remain substantial.

The technology gap, a critical issue in today's interconnected world, is being addressed from multiple perspectives. The United Nations has highlighted the disparity in the context of Least Developed Countries (LDCs), noting that despite significant technological advancements, the economic and social benefits are primarily concentrated in developed countries.⁸ This imbalance suggests that if these technology gaps are not addressed promptly, LDCs may struggle to achieve the 2030 Agenda and its Sustainable Development Goals. To bridge this gap, the World Economic Forum (WEF) has initiated measures to harmonise technology and policy. In 2017, the WEF established the Centre for the Fourth Industrial Revolution (C4IR) Network⁹, fostering collaboration between governments, businesses, start-ups, and civil society. This network is instrumental in developing policy frameworks and piloting new approaches to technology regulation and adoption. A report by McKinsey indicates that the COVID-19 pandemic has also expedited the pace of digital enablement, potentially influencing the technology landscape in Europe (Smit et al., 2022). However, the International

8 <https://www.un.org/ldcportal/technology-gap> (Accessed: January 16, 2024)

9 <https://centres.weforum.org/centre-for-the-fourth-industrial-revolution/home> (Accessed: January 10, 2024)

Telecommunication Union (ITU) points out that a significant innovation gap lies at the heart of the digital divide¹⁰. This gap persists even in developed countries, where many national policies and strategies have been unsuccessful in closing it. This underscores the complexity of the issue and the need for comprehensive and globally coordinated efforts to bridge the technology gap.

This chapter aims to address selected aspects of the magnitude of the technological divide. It commences with a concise introduction of three fundamental models that shed light on this gap, *i.e.*, the Technological Gap Model (Posner 1961), the Product Lifecycle Model (Vernon 1966), and the “Technology Gap” Model of International Trade (Krugman 1985). This part begins with an examination of the Frontier Technology Readiness Index, a tool developed by the United Nations Conference on Trade and Development (UNCTAD). Following this, it delves into distinct facets of the technological gap, highlighting the disparities in various areas, including the divide in innovation, the digital divide, and the gap in high-technology manufacturing. Each of these elements plays a crucial role in understanding the complexities of the technological gap. By examining them in detail, we can gain a more comprehensive understanding of the issue at hand. In conclusion, the discussion provides selected insights into the dynamics of the technological divide between advanced and emerging economies. It sheds light on the factors that may either narrow or widen this gap, underscoring the complex interplay of economic development and technological advancement.

3.1. A challenge with the technological gap

Technological advancements exert a profound influence on both production and trade, either through the introduction of innovative production techniques for existing commodities or the inception of new product categories. Technology and Innovation, inspired by Schumpeter’s growth models, describe a scenario where companies operate in an industry using labour as the only input. Each company has a technology level, and the production cost per unit is independent of the quantity produced. The industry is characterised by a pair of integers representing

10 <https://www.itu.int/en/ITU-T/focusgroups/innovation/Pages/default.aspx> (Accessed: January 16, 2024)

the leader's technology level and the technological gap between the leader and the follower. The model assumes that no firm can advance more than one technological level ahead of the other due to knowledge spillovers. If a leading firm innovates, the lagging firm automatically learns to replicate the previous technology, remaining only one step behind. Therefore, there are two types of sectors: levelled sectors (where firms are technologically equal) and unlevelled sectors (where one firm is one step ahead). The model also discusses the maximisation of utility subject to a budget constraint, leading to certain first-order conditions. The equilibrium profit flows of the leader and follower in an industry depend only on the technological gap between the two firms. The model also references works that analyse cases where there is no limit to how far ahead the leader can get.

While this model provides insights into the dynamics within an industry, it is also crucial to consider the broader perspective of technological disparity between countries. Gerschenkron (1962) revived Schumpeter's approach to shed light on this aspect. In his approach, the technological disparity between countries at the forefront of innovation and those trailing behind. This gap, while offering the latter a significant opportunity for rapid growth through the adoption of advanced technologies, also presents numerous challenges that may hinder these countries from fully exploiting the potential advantages. Gerschenkron often cited Germany's efforts to close the gap with the United Kingdom over a hundred years ago as a prime example. The UK's initial industrialisation phase was characterised by labour-intensive, small-scale technology. However, as technology evolved, it became more capital and scale-intensive, altering the entry conditions by the time Germany embarked on its industrialisation journey. Consequently, following Gerschenkron, Germany had to devise new institutional mechanisms, particularly in the financial sector, to surmount these hurdles – mechanisms that were largely absent in an already industrialised nation (Gerschenkron, 1962, pp. 7). He believed these experiences were also applicable to other technologically deficient countries.

Having understood the broader perspective of technological disparity between countries, we can now delve into specific models that aim to illuminate the intricacies of international trade in the context of technological progression, *i.e.*, the Technological Gap or Imitation Lag Model, the Product Lifecycle Model, and the "Technology Gap" Model of International Trade. The latter two, developed by Vernon (1966) and Krugman (1985) respectively, build upon the foundational concepts of the first model introduced by Posner (1961).

3.2. The Technological Gap Model

The Technological Gap Model posits that technological evolution is an ongoing process (Posner 1961). He argues that trade can emerge even between nations with similar factor proportions and preferences, due to the ceaseless cycle of invention and innovation (*ibid.*, pp. 323). This theory suggests that when a company creates a novel product, it first tests it in the domestic market. If successful, attempts are made to launch it in international markets. These new products grant the manufacturing firm or exporting nation a temporary monopoly in global trade, often safeguarded by patents and copyrights (*ibid.*, pp. 324). This monopoly allows the exporting nation to enjoy a comparative advantage until foreign producers replicate the new product variants or learn new production methods.

The theory is based on several assumptions (*ibid.*, pp. 323–325): (i) There exist two countries – A and B. (ii) Both countries have similar factor endowments. (iii) Both countries have comparable demand conditions. (iv) The factor price ratios in both countries are identical prior to trade. (v) The two countries employ different techniques. (vi) If country A cannot produce country B's output at a certain time, this is under the condition that country A could adapt to country B's superior technique after a certain period, known as the learning period, which is a technological concept of the time that takes for a firm to learn and adapt to new innovations or changes in the market. (vii) The economies of A and B will evolve to become identical.

According to Posner, if the two countries are otherwise identical, trade between them will be generated by technological innovation, depending on the net effect of the demand and imitation lags. The delay between the introduction of new products and the arrival of their foreign substitutes is referred to as the technological or imitation gap. The (economic) “reaction lag” is a component of the imitation lag and measures the speed of a firm's response to potential competition. This lag is not uniform across industries and can vary between domestic and foreign markets. In an international model, Posner distinguished the following (*ibid.*, pp. 331–333): (i) the “foreign reaction lag”, which is the time that elapses between the successful utilisation of an innovation by a foreign firm and the point when domestic producers consider the new good as a potential competitor; (ii) the “domestic reaction lag”, which is the time it takes for a firm to respond to potential competition in its domestic market; (iii) the “demand lag”, which can delay the successful sales of innovated foreign products

on the domestic market, and which arises from the separation of national markets and can be significant. If the “demand lag” exceeds the “imitation lag”, producers in the imitating country would adopt the new technology before their domestic consumers began demanding the new good, preventing technological innovation from generating trade.

Posner uses the term “dynamism” to describe the combination of innovation and imitation lag. He defines a dynamic country in international trade as one that innovates at a higher rate and imitates foreign innovations more quickly (*ibid.*, pp. 337). If one of the two trading countries exhibits greater dynamism, the other will experience market erosion and a resulting trade balance deficit. Conversely, if the imitation lag is longer than the demand lag, innovation is likely to generate international trade. Thus, the trade pattern between the two countries will depend on the relative lengths of the two lags.

Countries with a technological edge often have the advantage of producing and exporting high-tech goods, while those lagging may find themselves importing such products. Over time, however, technology diffusion occurs, and the “imitation lag” decreases as other countries begin to catch up, adopt, and adapt these advanced technologies. This process can lead to shifts in trade patterns as countries move up the technological ladder and start producing goods they once imported.

3.3. The Product Lifecycle Model

The product cycle model, initially proposed by Raymond Vernon (1966), and later endorsed by G.C.Hufbauer (1978, 1966) and Louis T.Wells (1974), posits that a product first sees production and exportation from the country of innovation but, ultimately, the same country becomes an importer of the same or a differentiated version of the product.

The entire framework is rooted in the experiences of the United States. This nation, with its wealth of capital, leads in product innovation thanks to its highly skilled labour force, high-income per individual, and expansive domestic market. Thus, the model is built on several assumptions: (i) New products are first introduced by producers in countries with abundant capital. (ii) Firms that innovate have a perceived or actual monopolistic edge. (iii) The domestic market’s needs and opportunities stimulate the creation of a new product. (iv) The firm that

innovates has limited knowledge about foreign market conditions. (v) The home environment in the countries that initially innovation differs from that in other advanced countries. (vi) A triggering event, such as the emergence of competing producers, may lead to the product being exported. Further, the model's central premise is that a product's factor requirements change over its lifespan, resulting in a production cycle (Vernon 1966, pp. 191–193).

Considering these elements, it's recognised that the creation of new items is expected to be focused on developed nations, where the risks associated with innovating a new product can be absorbed by relatively wealthy firms. However, as new products are initially adopted by other developed nations and eventually by less developed ones when the product standardises, the comparative advantage diminishes (*ibid.*, pp. 202). In other words, when the product and its manufacturing process become standardised, manufacturers from other nations can join the market, provided that the pricing patterns of their countries' factors offer them a competitive edge over the initial manufacturers (*ibid.*, pp. 191–192). This could lead to other developed or even developing nations beginning to manufacture these products. There's also a possibility that the initial manufacturing companies set up production facilities in other nations to take advantage of more favourable pricing factors (*ibid.*, pp. 205). Therefore, the original manufacturing country might experience a drop in exports and might even turn into an importer of the same or an enhanced version of the product (*ibid.*, p. 194).

Vernon's trade pattern is observed in a variety of products. In recent times, the evolution of the smartphone industry serves as another example. Initially, US companies, such as Apple, pioneered the global smartphone market with the introduction of the iPhone. This innovative product, with its user-friendly interface and unique design, quickly gained popularity worldwide. However, South Korean and Chinese manufacturers like Samsung and Huawei soon adopted the smartphone technology, introducing their own versions of smartphones. These companies were able to produce smartphones at a lower cost, allowing them to capture a significant share of the global market. As technology advanced, US companies introduced new features like touch ID, face ID, and advanced camera systems. Yet again, manufacturers from South Korea and China were quick to adopt these technologies, producing their versions at lower costs and continuing to expand their market share. This pattern is like the product cycle observed in the electronics industries between the US and Japan given by Vernon.

The model outlines four pivotal stages in a product's lifecycle:

- ✦ **Initial Launch:** Advanced nations, such as the USA, with their robust manufacturing capabilities, release products designed for high-income markets and to optimise labour. Initially offered locally, these products, upon gaining domestic approval, are then shipped to similarly affluent markets. During this period, the originating producers temporarily hold a near-monopoly in both local and international markets.
- ✦ **Competitive Emergence:** Producers from other countries start to challenge this dominance, leveraging lower labour costs and beginning to enjoy the benefits of scale economies previously exclusive to developed nations.
- ✦ **Market Penetration:** Eventually, these international producers make inroads into the innovator's home market, overcoming barriers like transport expenses and tariffs. The pioneering nations begin to import more of these products than they export.
- ✦ **Innovation:** Consequently, original innovator countries like the USA are compelled to develop novel product variations, catering to the sophisticated tastes of wealthy consumers both at home and abroad.

Vernon's model has faced scrutiny for its potentially misguided premises. Firstly, it is a misconception to believe that the firm introducing an innovation is oblivious to the circumstances in foreign nations. Secondly, the domestic environment of the innovating nation does not significantly differ from that of other developed countries as all possess the necessary infrastructure for product innovation. For instance, the development of electric vehicles (EVs) is not exclusive to countries with abundant capital. In fact, the push for EVs in countries like Norway and the Netherlands is driven more by the desire to preserve capital and natural resources than to reduce labour costs. Thirdly, it is a fallacy to think that innovation is confined to the developed world. Countries considered less developed, such as Brazil, Mexico, South Korea, China, and India, have been tailoring products to their local conditions and fostering innovation. For example, China and India have made significant strides in the technology sector, with companies like Alibaba and Reliance Jio introducing ground-breaking innovations. Lastly, it is incorrect to assume that innovations are solely stimulated by the prospects offered by the domestic market. In many cases, the motivation to maximise exports to foreign countries also drives innovation. For example, South Korea's Samsung and LG have consistently innovated to maintain their global market share in the electronics sector.

3.4. The “Technology Gap” Model of International Trade

Krugman (1985) presents a simplified model of technology and comparative advantage, based on three assumptions: (i) There is only one factor of production, eliminating complications from factor-biased technical change and the influence of factor endowments on comparative advantage. (ii) Countries can be ranked by technological level, with higher-ranked countries having an absolute advantage in all sectors. (iii) Sectors can be ranked such that more advanced countries have a greater productivity advantage in higher-numbered sectors (*ibid.*, pp. 39–41). From these assumptions, two propositions arise:

1. The wage rate must increase as we move up the “ladder” of countries.
2. The products produced by any country must lie “upscale” from those produced by less-advanced countries and “down-scale” from those produced by more-advanced countries.

This results in a pattern of specialisation where each country has a “niche” in the scale of goods, with more technologically advanced countries having a comparative advantage in higher-end goods. This model provides a clear description of the pattern of comparative advantage in a many-good, many-country world, preserving the Heckscher-Ohlin theory’s feature that comparative advantage reflects an interaction between the characteristics of countries and goods. The next step is to examine the effect of technical change on the pattern of specialisation and welfare, which requires introducing a demand side (*ibid.*, pp. 41). Further, Krugman concentrates on a two-country model where both nations share identical Cobb-Douglas preferences (*ibid.*, pp. 41). They produce a range of goods, with each country having a productivity advantage for certain goods. The share of income spent on a country’s goods increases with the range of products it produces. Equilibrium in the model is achieved when the supply and demand for each country’s labour are equal, and the balance of payments is maintained (*ibid.*, pp. 42). Changes in the range of goods produced by a country must be offset by adjustments in relative wages (*ibid.*, pp. 43).

Widening the gap

According to Krugman – the impact of technological improvement in a more advanced country (Country 1) on itself and a less advanced country (Country 2): When Country 1’s technology improves, its productivity advantage in all sectors increases, leading to a rise in its relative wage and a reduction in the range

of products manufactured by Country 2. However, the relative wage increase is less than the productivity increase in the original marginal good. The advanced country (Country 1) benefits from this change as its real wage in terms of its own and the other country's products rises due to increased productivity. Country 2, despite a fall in its relative wage, share in the world income, and a reduction in its technologically most-progressive sectors, is also better off. This is because the prices of Country 1's goods in terms of Country 1's labour fall, and Country 2 still has the option of producing transitional goods for itself at unchanged labour cost. Therefore, technological progress in the leading country, even if it widens the gap, benefits the less advanced country as well. However, technical progress by the less advanced country may not benefit the advanced country and could potentially make it worse off (*ibid.*, pp. 41–43).

Narrowing the gap

Opposite to the above-described case, the impact of technological improvement in a less advanced country (Country 2) on itself and a more advanced country (Country 1): When Country 2's technology improves, its productivity in all sectors increases, leading to a decrease in the wage differential and an increase in the range of products it produces. For Country 1, the real wage remains unchanged for its exported products, increases for products whose production moves to Country 2, and varies for products produced by Country 2 throughout. The purchasing power of Country 1's labour increases for goods near the original margin but falls for traditional imports from Country 2. The overall effect on real income in Country 1 depends on the balance between gains from falling prices of medium-technology goods and losses from worsened terms of trade against low-technology products. If the technology gap closes completely, Country 1 loses the gains from trade and may be worse off, indicating that further narrowing of a small technology gap can hurt the technological leader; thus, an asymmetry in the effects of technological progress between more- and less-advanced countries can be observed. Technological advancement in a leading country, which widens the technology gap, benefits less advanced countries. However, when less advanced countries "catch up" and narrow the gap, it can negatively impact the leading country. This asymmetry can be understood in terms of export- and import-biased growth. Technical progress is typically biased towards technology-intensive industries, which are the export industries of the leader. Thus, progress in the leading country is effectively biased towards goods not produced by the other country, while progress in the follower

competes with the leader's exports. A concerning implication of this analysis is that the real income of the technological leader depends on maintaining its lead. Catching up by other nations can lead to a decline in the leader's relative income and potentially its absolute standard of living. This could be interpreted as a motivation for continuous innovation or as a case for technological protectionism, limiting the free flow of information. While there are strong political and humanitarian arguments against such a policy, an economic case exists for it (*ibid.*, 43–45).

Krugman's model is based on Ricardian relationship between technology and trade, where countries and goods can be ranked by technology level and intensity, respectively (*ibid.*, pp. 47). The model considers two scenarios: technological progress in an advanced country that widens the technology gap, and progress in a less advanced country that narrows the gap. In the first scenario, the leader's progress increases trade opportunities and raises real income in both countries. In the second scenario, the follower's "catch-up" tends to hurt the leader by eliminating trade gains, suggesting that the leader's real income depends on preserving its lead, making a case for technological protectionism.

The technological advance leads to a rise in the technology-intensity of a country's exports, but this is a result, not a cause, of progress. According to Krugman, subsidising high-technology industries does not necessarily promote growth (*ibidem*, 48). In fact, the model shows that the technological intensity of exports and real income move in opposite directions. Mimicking the symptoms of progress does not create its reality, and the attempts to spur growth by promoting high-technology industries may lead to excess capacity and disappointment.

3.5. Measuring the technological disparities

Understanding technological disparities is crucial in today's digital age, where technology plays a pivotal role in economic growth and international trade. This part delves into the various approaches to measure these disparities, with a focus on the role of frontier technologies. However, defining frontier technologies presents its own set of challenges. There are numerous approaches to defining them (Table 1). The market value of frontier technologies is projected to escalate to an impressive USD 9.5 trillion by the year 2030 (Hoffmeister, 2020).

McKinsey’s Technology Trends Outlook 2023¹¹ indicates that generative AI could contribute up to 4.4 trillion USD to the economy through a mix of specific and broad applications, including productivity-enhancing tasks like drafting emails. The report also predicts that four sectors – automotive, chemicals, financial services, and life sciences – could be the first to benefit economically from quantum computing, potentially generating up to 1.3 trillion USD in value by 2035. While investment in many tech trends has tightened year on year, the potential for future growth is high, as shown by the recent recovery in tech valuations¹. In fact, total investments remained robust in 2022, exceeding 1 trillion USD, reflecting strong confidence in the value potential of these trends.

TABLE 1. Emerging technologies with the biggest potential of economic transformation

SOURCE	TECHNOLOGY TRENDS
Gartner	<p>Industry 4.0 Frontier Technologies: Generative Cybersecurity AI, Neuro-Symbolic AI, AI Simulation, Casual AI, AI TRISM, AI-Augmented, Generative AI, Internet of Things, Cloud-Out to Edge, Big Data, Graph Data Science (GDS), Blockchain, Postquantum Cryptography, Homomorphics Encryption; Cybersecurity Technologies: Cybersecurity Mesh Architecture, Generative Cybersecurity AI; Development and Operations (DevOps) Technologies: GitOps, Value Stream Management Platforms; Financial Technologies (FinTech): Augmented FinOps; Artificial Intelligence (AI) and Machine Learning (ML) Technologies: Neuro-Symbolic AI, AI Simulation, Casual AI, AI TRISM, AI-Augmented, Generative AI, Federated Machine Learning; Cryptography Technologies: Postquantum Cryptography, Homomorphics Encryption; Cloud Computing Technologies: Cloud Development Environments, Cloud Sustainability, Internal Developer Portal, Industry Cloud Platforms, Cloud-Out to Edge, Cloud Native; Web Development Technologies: WebAssembly (Wasm); Open Source Technologies: Open-Source Programme Office; Software as a Service (SaaS) Technologies: API-Centric SaaS; Software Engineering Technologies</p>
MIT Technology Review	<p>Industry 4.0 Frontier Technologies: AI That Makes Images (Artificial Intelligence), Chips RISC-V (Big Data), Mass-Market Military Drones (Drone Technology), 3D-Printing Organs (3D Printing), Super Apps (Internet of Things), Quantum-Ready Cryptography (Blockchain), Exascale Computing (Big Data); Green Frontier Technologies: Electric Vehicles (EV) (Electric Vehicles), Battery Recycling (Biofuels, Biogas and Biomass); Other Frontier Technologies: CRISPR for High Cholesterol (Gene Editing), James Webb Space Telescope (Nanotechnology), Genomic Sequencing Tools (Gene Editing), Hydrogen Planes (Nanotechnology)</p>

¹¹ <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-top-trends-in-tech> (Accessed: January 12, 2024)

SOURCE	TECHNOLOGY TRENDS
McKinsey Global Institute	<p>Artificial Intelligence and Machine Learning: Machine learning (ML), Computer vision, Natural-language processing (NLP), Deep reinforcement learning, Generative AI, Fine-tuning in deep learning, Explainable AI (XAI); Data Management and Model Operations: Automated data-management software, Optimise ML models, Engineer features, Standardise processes, Model deployment (tests and validates ML models), Live-model operations; Computing Architectures and Hardware: Cloud computing specific architectures, Domain specific architectures, High-capacity compute for ML work-flows, Graphical processing units (GPUs), Tensor processing units (TPUs), Quantum sensing, Quantum sensors; Software Development and Operations: Integration/tooling layer, Large-language- programming framework LangChain, Vector databases: Weaviate, Pinecone, Low-code platforms, No-code platforms, Infrastructure as code, AI-generated code, Microservices and APIs, AI-based testing, Automated code review; Security and Privacy: Zero-trust architecture (ZTA), Passwordless identity, Self-sovereign identity (SSI), Privacy engineering, Technology resilience, Immutable backup, Self-healing networks; Blockchain and Web3: Web3, Blockchain, Digital assets, Digital tokens, Digitally native intangible items, Native cryptocurrencies, Governance tokens, Stablecoins, NFTs, Tokenised real-world, Tokenised financial assets, Tokenised cash; Connectivity and Networks: Advanced connectivity, Optical fiber, Low-power area networks, Wide-area networks, Narrowband IoT, LTE-M, LoRa, Sigfox, Wi-Fi 6, Wi-Fi 7, High-altitude platform systems (HAPS), LEO satellite constellations, Direct-to-handset satellite connectivity; Sensors and IoT: Haptics, On-body sensors, Off-body sensors, Location-mapping software, IoT devices; Edge Computing: On-premises edge, "Close to the action" edge, Operator edge computing, Network edge computing, Mobile edge computing (MEC), Metro edge; Biotechnology and Health-care: Omics, Genomics, Proteomics, mRNA therapy, Viral-vector gene therapy, Tissue engineering, Cells engineering, Organ engineering; Materials and Chemicals: Biomaterials, Bio-based drop-in chemicals, Bioreplacements, Bio-better materials, Biochemical synthesis, Cultivated meat; Space Technologies: Small satellites, CubeSat architectures, Remote sensing, SWaP-C advancements, Launch technology advancements, Laser communications, Nuclear propulsion, Electronically scanned antennas, Automated satellite operations; Green frontier technologies: Carbon capture, utilisation, and storage (CCUS), Carbon removals, Natural climate solutions, Circular technologies, Alternative proteins and agriculture, Water and biodiversity solutions and adaptation, Technologies to track net-zero progress.</p>
UNCTAD	<p>Industry 4.0 frontier technologies: Artificial intelligence (AI), Internet of things (IoT), Big data, Blockchain, 5G, 3D printing, Robotics, Drone technology; Green frontier technologies: Solar PV, Concentrated solar power, Biofuels, Biogas and biomass, Wind energy, Green hydrogen, Electric vehicles; Other frontier technologies: Nanotechnology, nanotech, Gene editing</p>
World Bank	<p>World Bank uses the Organisation for Economic Co-operation and Development in collaboration with Eurostat, which differentiates four classes of exports: high, medium-high, medium-low, and low-technology. The World Bank employs a "product-centric" method, as opposed to a "sector-centric" one, which is grounded on the intensity of R&D (calculated as expenditure over total sales) for various product groups originating from countries like Germany, Italy, Japan, the Netherlands, Sweden, and the United States. This categorisation hinges on the significance of R&D spending in relation to the gross output and value added by diverse industry types that manufacture export goods. High-tech industries encompass sectors like aviation, computing, pharmaceuticals scientific instruments, and electrical machinery; medium-high-tech covers areas like automotive, electrical equipment, and the majority of chemical industries; medium-low-tech comprises sectors like rubber, plastics, basic metals, and shipbuilding; low-tech industries involve sectors like food processing, textiles, apparel, and footwear.</p>

Source: Own elaboration.

There are various methods to assess the technological divide, in which technology serves as a crucial catalyst for economic expansion and global commerce. One common measure of the innovation divide is the assessment of a country's ability to use, adopt, and adapt these innovations. This can be evaluated by considering factors such as the number of providers of frontier technology, patents related to frontier technologies, and the country's share of publications pertaining to frontier technology. Another methodology involves analysing the international trade flows of high-tech manufacturing, such as Foreign Direct Investment (FDI), and the correlation between exports from high-tech industries and GDP growth, among other factors. However, it is crucial to acknowledge that existing surveys have data limitations. To address this, the World Bank has recently introduced a new framework, known as the Firm-level Adoption of Technology (FAT). This framework facilitates an in-depth examination of the process of technology adoption by firms and its variation across firms, sectors, and countries (Cirera *et al.* 2022). However, the FAT framework is currently limited to developing countries. This limitation constrains the scope of the study and prevents it from providing a comprehensive view of the international trade landscape.

Here, to elucidate the technological disparity between advanced and developing economies, the structure of the section is as follows:

- ✦ **Innovation divide** (Section 3.1) explores the Frontier Technology Readiness Index developed by The United Nations Conference on Trade and Development (UNCTAD), which can highlight disparities in technological readiness and innovation capabilities between different economies.
- ✦ **Digital divide** (Section 3.2) examines the disparities in use of information and communication technologies (ICT); the role of ICT services in international trade and the significance of digitally deliverable services are discussed, providing insights into the extent of digitalisation in various economies.
- ✦ **High-Tech manufacturing divide** (Section 3.3) focuses on the manufacturing sector, particularly the role of high-technology exports; this shed light on the differences in manufacturing capabilities and the adoption of high-tech processes between advanced and developing economies.

Collectively, these subsections offer a comprehensive understanding of the various divides and their impacts on global trade, technology, and manufacturing. They effectively illustrate the technological gap that exists between advanced and developing economies.

Innovation divide

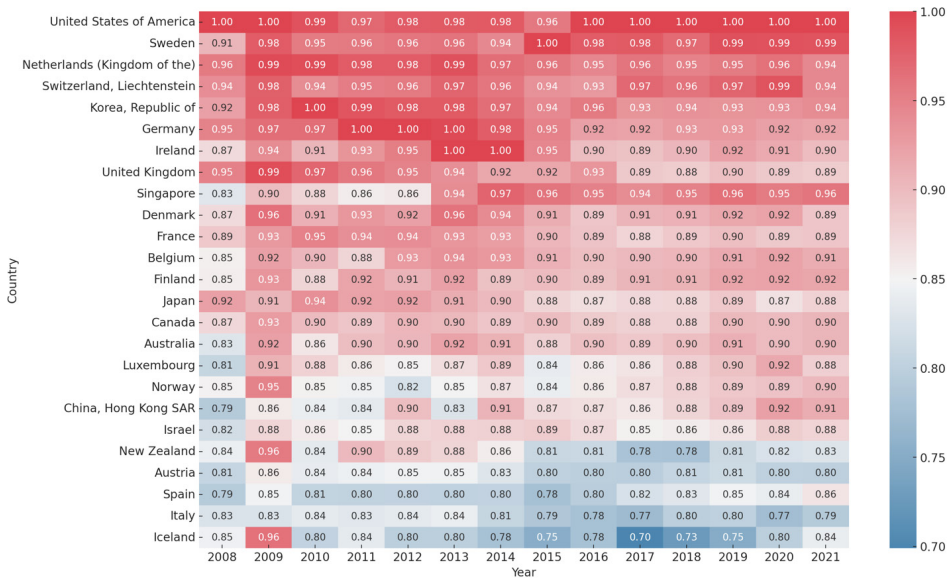
The Frontier Technology Readiness Index¹² (FTRI) measures a country's readiness to engage with new technologies. It considers factors like infrastructure, technological knowledge, access to finance and human capital. This index is crucial for understanding how prepared different economies are to adopt and benefit from emerging technologies. Figure 1 presents statistics on the Frontier Technology Readiness Index, developed by the United Nations Conference on Trade and Development (UNCTAD) that measures a country's readiness to engage with new technologies at these three stages. It considers factors like infrastructure, technological knowledge, and human capital. A higher score on this index would indicate a higher level of readiness: (i) Use the technology; (ii) Adopt the technology; (iii) Adapt to the technology.

The top countries span different continents and economic profiles, from technologically advanced nations in Asia (like Korea and China) to Western countries known for their innovation and industrial capacity (like the USA and Ireland). This diversity underscores the global nature of economic competitiveness, with different regions excelling in different aspects of the economy. The countries that consistently achieved high scores in the "Overall Index" include the United States of America, Sweden, the Netherlands, Germany, and Ireland. These countries have demonstrated strong and consistent performance, as indicated by their high average scores over the observed period. The United States of America consistently ranks as the top performer with an average index score near 1.0, indicating a robust and advanced technological infrastructure. Sweden, the Netherlands, and Switzerland (along with Liechtenstein) also show high average index scores, highlighting their strong technological capabilities. But some countries like Germany display a slight decline in recent years.

There is a notable presence of European countries in the top 25, reflecting the region's focus on technological development and innovation. Twelve economies, namely Sweden, the Netherlands, Germany, Ireland, Denmark, France, Belgium, Finland, Luxembourg, Austria, Spain, and Italy, rank among the top 25 worldwide. Smaller countries, like Luxembourg, Norway, Israel, and Iceland also make it to the top 25, indicating that size market is not a barrier to achieving high technological advancements.

12 <https://unctadstat.unctad.org/datacentre/reportInfo/US.FTRI> (Accessed: December 19, 2023)

FIGURE 1. Top 25 economies in the Frontier Technology Readiness Index annually (2008–2021)



Source: Own elaboration based on UNCTAD data¹³.

Upon examining the individual scores that contribute to the FTRI, it becomes evident that the representation of different countries varies across the years. This variation underscores the dynamic nature of technological advancement, with different nations ascending in technological prominence over time (as detailed in Table 2). High ICT scores are indicative of a robust technological infrastructure, extensive digital connectivity, and a population adept in technology use. Countries like the United Kingdom, South Korea, and Singapore, consistently appearing at the top, suggest their significant investment in digital infrastructure and technology adoption. Top scores in the Skills category reflect excellence in education and workforce development. Countries like New Zealand, Iceland, and Australia, consistently leading in this category, demonstrate their focus on enhancing skills and education systems. This can imply a strong emphasis on human capital development, which is crucial for economic growth and innovation. The United States and China frequently leading in R&D underscores their global leadership

13 <https://unctadstat.unctad.org/datacentre/dataviewer/US.FTRI> (Accessed: December 19, 2023)

in innovation, scientific research, and development. This is likely a result of substantial investment in research infrastructure and a strong culture of innovation. High scores in R&D are indicative of a country's potential for technological advancement and knowledge creation. Countries like Cyprus and Hong Kong, leading in this category, suggests a robust financial sector with efficient access to financial services and capital. This is essential for business growth and economic development. The dominance of certain regions in this category may also reflect regulatory environments favourable to financial activities. Ireland's consistent top performance in Industry Activity indicates a strong industrial sector, possibly driven by favourable corporate policies, a skilled workforce, and technology adoption in industrial processes. This category likely measures the vibrancy of the industrial sector, which is a critical component of a country's economic strength.

TABLE 2. Economies' performance in the respective FTRI categories (2008–2021)

YEAR	TOP ICT	TOP SKILLS	TOP R&D	TOP ACCESS TO FINANCE	TOP INDUSTRY ACTIVITY
2008	United Kingdom	New Zealand	USA	Iceland	Ireland
2009	South Korea	Iceland	USA	Cyprus	Ireland
2010	South Korea	New Zealand	USA	Cyprus	Ireland
2011	South Korea	New Zealand	USA	Cyprus	Ireland
2012	Hong Kong	Australia	USA	Cyprus	Ireland
2013	South Korea	Australia	China	Cyprus	Ireland
2014	Hong Kong	Australia	USA	Cyprus	Ireland
2015	Singapore	Australia	China	Cyprus	Ireland
2016	Singapore	Australia	China	Cyprus	Ireland
2017	Sweden	Australia	China	Cyprus	Ireland
2018	Denmark	Australia	China	Hong Kong	Ireland

YEAR	TOP ICT	TOP SKILLS	TOP R&D	TOP ACCESS TO FINANCE	TOP INDUSTRY ACTIVITY
2019	Denmark	Australia	China	Hong Kong	Ireland
2020	Luxembourg	Australia	China	Hong Kong	Ireland
2021	Iceland	Australia	China	Hong Kong	Ireland

Source: Own elaboration based on UNCTAD data¹⁴.

Countries that excelled in specific categories often also had high overall index scores. For example, the United States showed excellence in “Research and Development” along with a high “Overall Index”, indicating a well-rounded economic performance. However, there were exceptions. For instance, Cyprus led in “Access to Finance” but had relatively lower overall index scores, suggesting that while the country has a strong financial sector, it may have challenges in other areas. Certain countries maintained their top positions across multiple years in specific categories (*e.g.*, Ireland in “Industry Activity”), indicating sustained strengths in those sectors. The variation in the top countries over different years suggests a dynamic global economic environment where different nations rise in prominence in various sectors over time. For instance, from 2008 to 2021, Poland’s score increased by approximately 0.1375. The yearly scores, which started at 0.6367 in 2008, generally demonstrated an upward trend, despite experiencing some fluctuations. The score reached its zenith in 2020, peaking at 0.7786, before experiencing a slight dip to 0.7742 in 2021. This overall progress underscores a positive trajectory in Poland’s performance over this period.

The variation in country performances across these categories illustrates a global innovation divide. Developed countries with established infrastructures and policies tend to lead in multiple categories, whereas developing countries may lag, indicating disparities in innovation capacity. This divide can be attributed to differences in economic development, investment in R&D and education, technological infrastructure, and supportive policy environments. The changes in leading countries over the years suggests that the innovation landscape is not static and can be influenced by factors like policy changes, investment patterns, and global economic shifts.

14 <https://unctadstat.unctad.org/datacentre/dataviewer/US.FTRI> (Accessed: December 19, 2023)

Digital divide

International Trade in ICT Services

International Trade in ICT Services as a measure is crucial as it indicates how countries are positioned in the global information and communication technologies (ICT) sector. It highlights the digital divide in terms of access to and participation in the digital economy. This gap is particularly showing the difference in regard to technological development and digital infrastructure between developed and developing economies.

The gap is calculated as the difference between the share of developed economies and developing economies. As seen, the gap varies each year, with a general trend of increasing over time (Table 3). The largest gap was in 2021 at approximately 536 billion USD.

TABLE 3. Gap between developed and developing countries in ICT services share with per cent change (2005–2022)

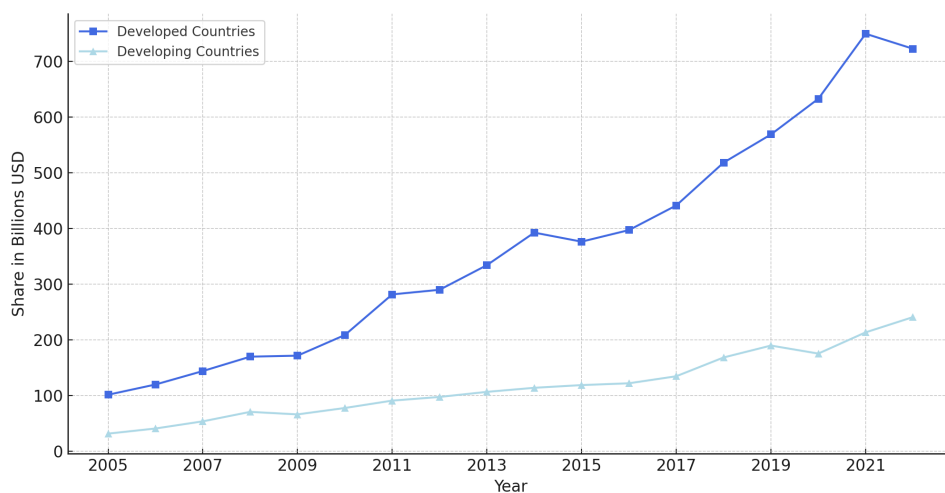
YEAR	GAP (IN BILLIONS USD)	% CHANGE
2005	69.83	–
2006	78.97	13.08%
2007	90.26	14.29%
2008	99.09	9.79%
2009	105.42	6.39%
2010	130.99	24.25%
2011	190.64	45.54%
2012	192.32	0.88%
2013	227.47	18.27%
2014	278.55	22.46%
2015	257.46	-7.57%
2016	274.97	6.81%
2017	306.59	11.50%
2018	349.78	14.10%

YEAR	GAP (IN BILLIONS USD)	% CHANGE
2019	378.96	8.34%
2020	457.30	20.68%
2021	535.96	17.20%
2022	481.64	-10.12%

Source: Own elaboration based on UNCTAD data¹⁵.

The gap between developed and developing countries in ICT services share has generally expanded over the years, indicating a growing digital divide (Figure 2). Developed Countries' growth, on average, was a bit over 31 billion USD per year, while developing Countries' average annual growth was approximately 9.4 billion USD.

FIGURE 2. A Share of ICT services in total services in billions USD (2005–2022)



Source: Own elaboration based on UNCTAD data¹⁶.

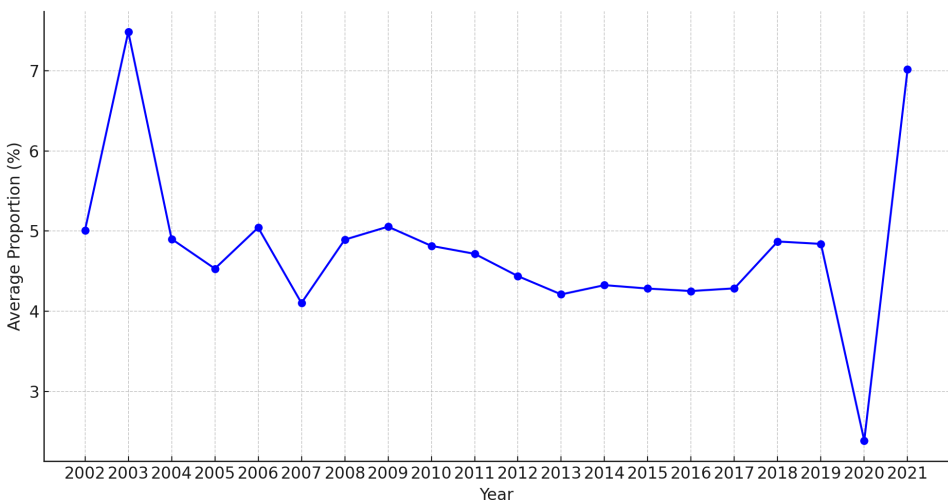
¹⁵ <https://unctadstat.unctad.org/datacentre/dataviewer/US.DigitallyDeliverableServices> (Accessed: December 19, 2023)

¹⁶ <https://unctadstat.unctad.org/datacentre/dataviewer/US.DigitallyDeliverableServices> (Accessed: December 19, 2023)

The largest increase in the gap occurred in 2011 with a 45.54 per cent increase from the previous year. The gap increased from 130.9 billion USD in 2010 to 190.64 billion USD in 2011. This represents a difference of 59.65 billion USD. There was a decrease in the gap in 2015 and 2022, which could suggest efforts to bridge the digital divide during those years. Despite the decrease in 2015, the gap increased significantly in the following years, reaching its peak in 2021 before decreasing again in 2022.

However, we observed that the percentage change from 2019 to 2020 was approximately 20.68 per cent, a significant increase. This could be indicative of the impact of global events in 2020, such as the COVID-19 pandemic, on the digital divide. From this point onwards, the gap started to decrease, reaching 10.12 per cent in 2022. The ongoing effects of the COVID-19 pandemic, political changes, economic crises, and climate events continued to play their roles. In 2022, as the pandemic eased in many countries and political changes and economic crises occurred, these events could have influenced the digital divide. They affect factors such as investment in ICT, access to technology, and the prioritisation of digital skills development (Figure 3).

FIGURE 3. A Proportion of total business sector workforce involved in the ICT Sector (2002–2020)



Source: Own elaboration based on UNCTAD data¹⁷.

17 <https://unctadstat.unctad.org/datacentre/dataviewer/US.TradeServICT> (Accessed: December 19, 2023)

There is a significant increase in the proportion of the total business sector workforce involved in the ICT sector from 2020 to 2021. This signifies a remarkable year-to-year global business growth of approximately 194 per cent, which is undeniably significant. Despite this, the value has not yet exceeded that of 2003, a year marked by swift digitalisation and technological progress. As the advancement of ICT persists and digital technologies become more ingrained in various sectors of our economies, the most needed skills continue to evolve and are in growing demand.

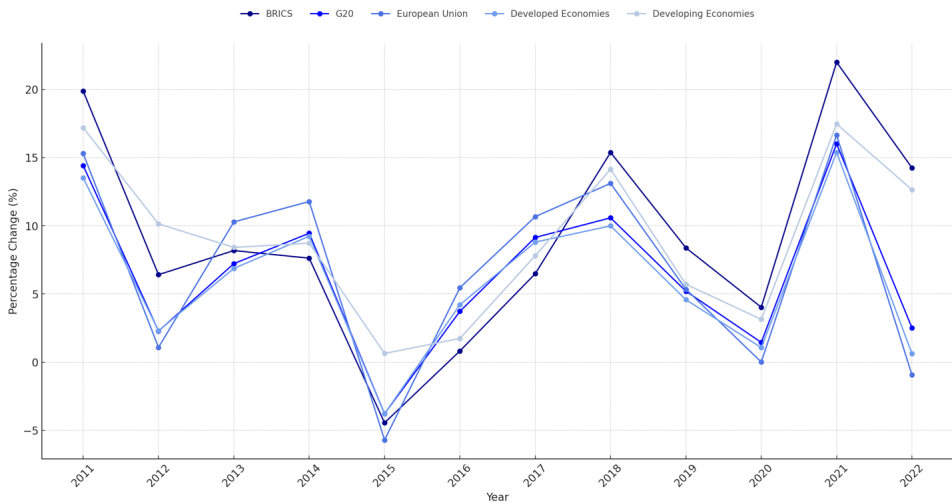
Digitally deliverable services in global trade

International trade in digitally deliverable services as a measure shows the extent to which countries are engaged in the digital economy through services that can be delivered online. It reflects a country's digital connectivity, the sophistication of its service sector, and its integration into the global digital marketplace.

The year-on-year percentage change for digitally deliverable services for BRICS's, G20, European Union Economies, Developed Economies, and for Developing economies (Figure 4) reflects the very dynamic nature. Latest strong growth from 2020 to 2021 across all groups might indicate a surge in digital services, possibly accelerated by the COVID-19 push towards digitalisation.

From 2011 to 2012, the BRICS countries experienced moderate to high growth, peaking in 2011 at 19.89 per cent. The growth remained steady but slightly declined in 2013–2014. In 2015, there was a significant decline of -4.45 per cent, indicating a contraction in digitally deliverable services. However, the period of 2016–2017 saw a recovery and moderate growth, peaking again in 2017 at 6.49 per cent. In 2018, there was strong growth of 15.39 per cent, possibly due to economic or digital advancements. The growth in 2019–2020 was moderate, though lower than in 2018. Finally, in 2021–2022, there was substantial growth, especially in 2021 at 22.01 per cent, suggesting a significant expansion in digitally deliverable services.

In 2011–2012, the growth in G20 countries slowed down significantly. However, there was a recovery and strong growth in 2013–2014, especially in 2014 at 9.46 per cent. In 2015, there was a decline, similar to the BRICS countries, indicating a possible global trend. The period of 2016–2017 saw a recovery with increasing growth rates. In 2018–2019, the growth was consistent, peaking in 2018 at 10.59 per cent. However, the growth slowed down from 2020–2022, possibly impacted by global events like the COVID-19 pandemic.

FIGURE 4. Change in international trade in digitally-deliverable services (2011–2022)

Source: Own elaboration based on UNCTAD data¹⁸.

In 2011–2012, there was a sharp decline in growth in the European Union. However, there was a strong recovery in 2013–2014, peaking in 2014 at 11.79 per cent. In 2015, there was a decline, mirroring global trends. The period of 2016–2017 saw a recovery and strong growth. In 2018–2019, the growth was good, especially in 2018. In 2020, there was almost no growth, likely due to pandemic impacts. However, there was a strong recovery in 2021, followed by a slight decline in 2022. The Developed Economies followed a similar trend to the European Union, with notable growth in certain years (2014, 2017, 2021) and declines or slowdowns in others (2015, 2020).

In 2011–2012, the Developing Economies experienced high growth in 2011, which decreased in 2012. The growth remained steady in 2013–2014. In 2015, there was minimal growth, indicating a stagnant period. However, the period of 2016–2017 saw a recovery, with consistent growth. In 2018–2019, there was strong growth, especially in 2018. Finally, from 2020–2022, there was continued growth, indicating resilience and expansion in digitally deliverable services.

¹⁸ <https://unctadstat.unctad.org/datacentre/dataviewer/US.DigitallyDeliverableServices> (Accessed: December 19, 2023)

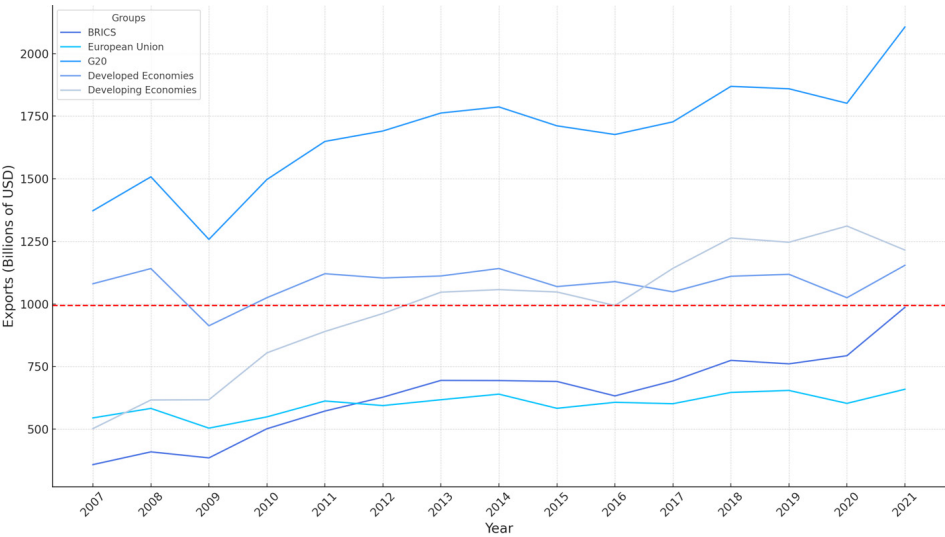
High-Tech manufacturing divide

High-technology export growth

High-technology export reflects a country’s capacity for innovation and production in high-tech industries (for high-technologies refer to Table 1). By examining high-technology exports, the analysis demonstrates the technological capabilities of different economies and their positions in the global market. This metric helps illustrate the disparity between countries that are leading in technology exports (often developed countries) and those that are not as advanced.

In 2007, the gap between the highest and lowest high-tech exports across all countries was the smallest (Figure 5). Over the years, there appears to be a general upward trend in high-technology exports across most groups, suggesting increasing global engagement in high-technology sectors.

FIGURE 5. High-technology export in USD (2007 to 2021)



Source: Own elaboration based on World Bank data¹⁹.

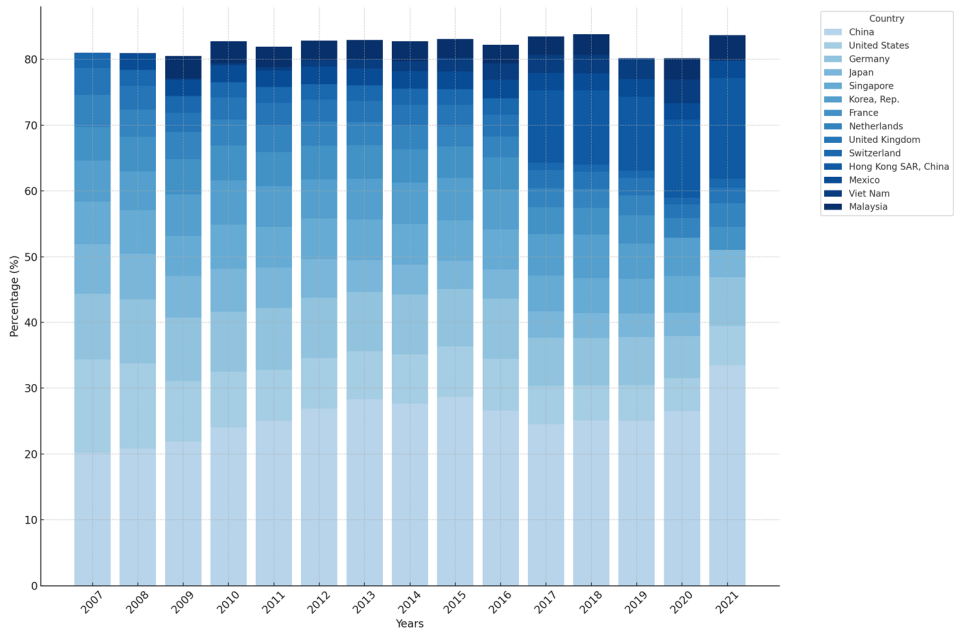
19 <https://databank.worldbank.org/reports.aspx?source=2&series=TX.VAL.TECH.CD&country=> (Accessed: December 19, 2023)

Examining the annual variation in the high-tech export gap, the divergence has witnessed a substantial escalation in the years following 2007, with a pronounced enlargement notably in 2010 and 2011. However, there were instances when the gap slightly diminished, especially in 2009, 2014, and 2015, hinting at a trend towards a contracting gap during these periods. Yet, the most substantial escalation transpired from 2020 to 2021, signifying a recent considerable broadening of the gap. It is crucial to underscore that these trends are not linear, and the gap has experienced fluctuations over the years. The latest pronounced expansion of the gap could be attributed to a multitude of factors, not limited to the global economic repercussions of the COVID-19 pandemic, which might have impacted countries disparately based on their economic resilience and the composition of their high-tech sectors.

The BRICS group exhibited a significant surge in high-technology exports, with China's exponential growth being particularly noteworthy. This mirrors China's burgeoning role as a key exporter in high-tech industries. The European Union sustained a consistent and high level of exports throughout the period, signifying a robust and steady high-tech sector. The G20 demonstrated considerable growth, largely propelled by major economies, such as the United States, China, and Germany. Developed Economies maintained a high level of exports with minor fluctuations, indicative of their well-established high-tech industries. On the other hand, Developing Economies experienced growth in high-tech exports, albeit at a slower pace compared to their developed counterparts. This reflects the gradual integration and advancement of technology sectors in these economies. The differences in growth rates and export volumes between developed and developing economies highlight the disparity in technological advancement and production capacity. The role of major economies, like those in the EU, China, and the United States, is particularly prominent, showcasing their significant contribution to the global high-tech export market.

In 2018, the top 10 economies made up 68.01 per cent of the global exports (Figure 6). In 2019, this share slightly decreased to 65.28 per cent. In 2020, there was a further small decrease to 64.23 per cent. However, in 2021, there was a significant increase, with the top 10 economies making up 82.33 per cent of the global exports. This substantial increase indicates a major consolidation of export power within the top 10 economies. This could be due to economic recovery patterns following global disruptions and changes in trade policies (*e.g.*, nearshoring).

FIGURE 6. Comparative analysis of each economy’s contribution to global high-technology export



Source: Own elaboration based on World Bank data²⁰.

China’s share of global exports has shown a steady increase from 2007 to 2021, with a particularly notable jump from 2020 to 2021. This means that China’s exports constituted approximately 26.01 per cent of the total exports from all countries in the dataset over the specified period. Notably, other larger economies, such as the United States, United Kingdom, and Japan, have witnessed significant declines in their export shares over the period, which could be indicative of increasing competition from emerging markets. The United States experienced a decrease in its share from 2007 to 2017, followed by a partial recovery in 2021. Japan’s share has been on a declining trend over the years, indicating a relative decrease in its export power compared to other top

²⁰ <https://databank.worldbank.org/reports.aspx?source=2&series=TX.VAL.TECH.CD&country=> [Accessed: December 19, 2023]

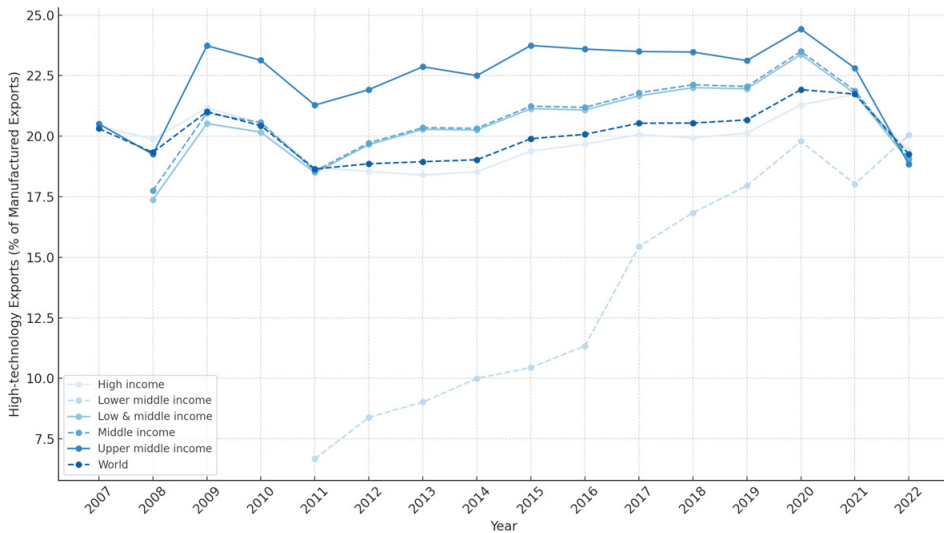
economies. Countries like Malaysia, Mexico, and South Korea have either stable or slightly increasing average annual growth rates. In contrast, Singapore, Switzerland, Germany, and the Netherlands show negative growth rates on average, indicating a relative decline or stability in their global export shares. Surprisingly, both Hong Kong and Vietnam demonstrate strong upward trajectories in their export shares, with Hong Kong having an exceptionally high average annual growth rate.

High-technology export in manufactured export

The World Bank's indicator of high-technology exports, expressed as a percentage of manufactured exports, serves as a measure of the proportion of a country's manufactured exports that fall within the high-technology category. This metric offers valuable insights into a country's technological prowess and its assimilation into global value chains. A high percentage indicates that a significant portion of a country's manufactured exports are derived from high-tech sectors. These sectors are typically distinguished by substantial research and development expenditures and a requirement for a workforce with a high level of skill. Industries with high and medium-high tech intensity make up more than two-thirds of the total manufacturing exports of the OECD²¹.

All economies show a general upward trend in high-technology exports as a percentage of manufactured exports, indicating a global shift towards more high-tech manufacturing (Figure 7). Towards the latter years, there seems to be a convergence in the percentages between the high-income and upper-middle-income economies, suggesting that the gap in high-tech manufacturing capability between these groups is narrowing. The middle-income group shows an overall increasing trend, with some fluctuations but generally remains below the world median baseline. The lower middle-income economies start with the lowest percentage of high-technology exports in 2007 but show a rapid increase around 2014, surpassing the middle-income group.

²¹ <https://databank.worldbank.org/metadataglossary/world-development-indicators/series/TX.VAL.TECH.MF.ZS> (Accessed: December 19, 2023)

FIGURE 7. High-technology exports (per cent of manufactured exports) by income group (2007–2021)²²

Source: Own elaboration based on World Bank data²³.

The year 2009 was marked by the aftermath of the 2008 global financial crisis. The high- and upper-middle-income groups, known for their advanced high-tech industries, experienced a substantial recovery in 2009 (Table 4). The high-income group saw a growth of +6.54 per cent, while the upper-middle-income group witnessed a more significant increase of +23.29 per cent. This rebound is likely indicative of their strong ability to recover and capitalise on global market demands in the wake of the crisis. Interestingly, the growth rate for high-income economies was lower than the global median baseline, which was +8.69

²² According to the latest definition by the World Bank, there are 83 high-income economies with an income of USD 13,846 or more. Additionally, there are 54 upper-middle-income economies with an income ranging from USD 4,466 to USD 13,845, 54 lower-middle-income economies with an income between USD 1,136 and USD 4,465, and 26 low-income economies with an income of USD 1,135 or less. More: <https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups> (Accessed: December 19, 2023)

²³ <https://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS?end=2022&start=2007&view=chart> (Accessed: December 19, 2023)

per cent. This suggests that the recovery was more evenly distributed across different income groups worldwide.

TABLE 4. The largest year-over-year increases and decreases in high-technology exports (per cent of manufactured exports) by income group (2007–2021)

ECONOMY	LARGEST INCREASE	LARGEST DECREASE
High income	2009 (+6.54%)	2022 (-10.68%)
Lower middle income	2017 (+36.17%)	2021 (-8.93%)
Low & middle income	2020 (+6.48%)	2022 (-12.83%)
Middle income	2020 (+6.55%)	2022 (-12.77%)
Upper middle income	2009 (+23.29%)	2022 (-17.42%)
World	2009 (+8.69%)	2022 (-11.42%)

Source: Own elaboration based on World Bank data²⁴.

In 2022, high-technology exports saw a significant global decrease of 11.42 per cent, reflecting the widespread impact across all regions and underscoring the interdependence of the global economy. This downturn could be attributed to global economic slowdowns, recovery challenges from the COVID-19 pandemic, and trade tensions. The upper-middle-income group (for instance Brazil, China, Russia, and South Africa) witnessing the most substantial decrease of 17.42 per cent among all groups, may be experiencing significant economic shifts. This decline could potentially be due to their dependence on specific high-tech sectors that were adversely affected by reductions in global demand or increased competitive pressures. All other income groups also experienced a decrease in their high-tech exports. The low- and middle-income group faced one of the most significant downturns, with a decrease of 12.83 per cent. The middle-income group also experienced

²⁴ <https://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS?end=2022&start=2007&view=chart> (Accessed: December 19, 2023)

a similar decrease of 12.77 per cent. The high-income group (for instance Germany, Poland, Taiwan, UK, and USA) noted a decrease of 10.68 per cent. Interestingly, the lower-middle-income group (for instance India or Vietnam) had already experienced a decrease of 8.93 per cent in 2021 – earlier than the other groups. This suggests that different income groups may be affected by global shifts at different times, indicating the complex dynamics of the global economy.

3.7. Narrowing or widening the technological gap?

In this chapter, the technological gap is analysed through three approaches – the Innovation Gap, the Digital Gap, and the High-tech Manufacturing Gap. The data suggests that the Innovation Gap is diminishing among developed economies. However, it appears to be expanding between developed and developing economies. When it comes to the digital divide, a distinct trend is apparent towards diminishing the gap between advanced and emerging economies, especially those within the BRICS group. However, throughout the period, developed countries maintained a consistently larger market share and exhibited a significantly higher growth rate than their developing counterparts. Regarding the high-tech manufacturing gap, the notable increase in export shares from leading economies during the post-Covid times indicates an expanding technological divide. These economies are advancing and exporting technology at a faster pace than the rest of the world, leading to an increased disparity in technological capabilities.

Innovation divide

The Innovation Divide, as quantified by the Frontier Technology Readiness Index (FTRI), provides insightful understanding into the dynamics of the progressively diminishing gap among various economies. Analysis of the FTRI from 2008 to 2021 demonstrates a consistent pattern of excellence in specific categories, indicative of focused technological advancements in top-performing countries. The United States and China, for instance, consistently led in research and development (R&D), mirroring a well-rounded economic performance coupled with a high “Overall Index” score. Similarly, Ireland’s sustained top performance in Industry Activity over the years reflects a strong, innovation-driven industrial sector. Moreover, countries like Iceland, leading in the ICT category by 2021, and Australia, consistently topping the Skills category, signify strategic investments

in digital infrastructure, education, and workforce development. This consistency in excelling in specific FTRI categories indicates a narrowing innovation gap within the developed economies, underlining their commitment to fostering sectors where they have competitive advantages.

Conversely, the FTRI also reveals the widening innovation gap, when contrasting developed and developing nations. The data suggests that countries with established infrastructures and supportive policies, like the United States and European Union, consistently lead across multiple FTRI categories, whereas developing countries often lag behind, indicating disparities in innovation capacity. For instance, Cyprus, despite leading in Access to Finance, showed relatively lower overall index scores, highlighting that excelling in a single category does not necessarily translate into comprehensive technological advancement. This disparity is further emphasised by the dynamic shifts in the leading countries across different categories over the years, reflecting the evolving global economic environment influenced by policy changes, investment patterns, and global economic shifts. For example, Poland's score, which started at 0.6367 in 2008, demonstrated an upward trend, peaking at 0.7786 in 2020 before a slight dip to 0.7742 in 2021, indicating a positive yet fluctuating trajectory in the global innovation landscape. This variation across countries and categories illustrates a pronounced global innovation divide, underpinned by differences in economic development, investment in R&D, education, technological infrastructure, and the policy environment.

Digital divide

The global uptake of ICT services and digitally deliverable services underscores a trend towards reducing the digital divide. This is particularly evident in the resilience and expansion of developing economies, as well as the notable growth in BRICS nations and the recovery trends observed across various groups post-2015. The acceleration in the adoption of digital services since the COVID-19 pandemic and the consistent recovery and growth in digitally deliverable services in recent years, especially in developing economies, hint at a narrowing gap. This is reinforced by the growth trends in developing economies that are either matching or exceeding those in developed economies.

Despite the overall growth in the share of ICT services, the market share disparity has broadened, with developed countries significantly extending their lead over time. This is evidenced by the consistently larger market share held by developed countries throughout the period and their considerably higher growth rate

compared to developing countries. The fluctuating growth rates, with developed countries experiencing acceleration around 2010 and 2015, and a deceleration or plateau around 2020, contrast with the more gradual yet persistent increase in developing countries. This disparity, along with the observed plateau or slight decline in developed countries post-2020, underscores a widening gap in the market share and growth potential between developed and developing nations.

High-Tech manufacturing divide

The overall upward trend in high-technology exports across all income groups suggests that countries are advancing their technological capabilities, which is a sign of a narrowing technological gap. However, a detailed examination reveals that the COVID-19 pandemic has significantly disrupted global value chains, with a pronounced effect on the export of high-tech products. The crisis led to supply chain interruptions that impacted exporters involved in these global networks. Companies engaged in international commerce had to contend with disruptions on a global scale, in addition to those at home. This led to a decrease in foreign demand for goods from exporting firms and a drop in supply, resulting in a shortage of intermediate inputs for importing firms. Companies that are part of global value chains, specifically those that import intermediate inputs and export goods, were confronted with these two additional obstacles to their production and sales capabilities. If we equate export share with technological advancement, the significant increase in the export shares of the top 10 economies in 2021 could be interpreted as a sign that the technological gap is widening. This could mean that the top economies are accelerating their technological advancements and export capacities faster than the rest of the world, possibly leading to a greater disparity in technological capabilities. On the other hand, the rise of emerging economies like China and Vietnam in export shares could suggest that these countries are developing their technological capabilities, which might indicate a narrowing gap with more developed economies. Some developed economies showing a decline in export shares might be facing increased competition from technologically advancing developing countries, which could be a sign of a narrowing technological gap.

Upon examining the data for high-technology exports (as a percentage of manufactured exports) by income group from 2007 to 2022, it becomes evident that the growth rate of high-technology exports varies significantly among different income groups. There is clear evidence of a narrowing gap, particularly between the upper-middle-income and high-income economies, while there

remains a persistent and, in some aspects, widening gap between the highest-income economies and the lower-income ones. The upper-middle-income countries have shown a significant increase in their share of high-technology exports through researched years, approaching the levels of high-income countries by 2021. Despite the convergence of the upper-middle-income countries with the high-income countries, there is still a persistent gap with the lower-middle-income and the middle-income countries, which may not be closing as rapidly. The dip in 2020 shows that external economic shocks can affect the technological export capabilities of countries differently. If high-income countries can recover more quickly from such events, the technological gap may widen during these periods for others. The lower-middle-income volatility seen around 2014, and the subsequent recovery, suggests that while there is potential for growth, these economies may be more susceptible to internal and external shocks, which can temporarily widen the technological gap.

However, export data is an indirect measure of technological capability. It can be also influenced by a variety of factors. For instance, fluctuations in commodity prices can affect the export values of countries, especially those that are major exporters of natural resources (see for example “Commodity Price Cycles: Drivers and Policies” 2022; Liu and Serletis 2022). Changes in global demand can impact export shares. For instance, the demand for medical supplies and technology surged in 2020 and 2021, which could have benefited economies with strong pharmaceutical or medical device industries like China (see for example Behnam *et al.*, 2020; Fleron *et al.* 2022). New trade agreements or tariffs can significantly impact export shares without reflecting technological changes (see for example, Falvey and Foster-McGregor 2022; Flach and Gräf 2020; Studnicka *et al.* 2019).

Conclusions

The approach taken to examine the technological gap, with a focus on innovation generation, high-tech manufacturing, and the digital economy, reveals a significant and persistent disparity between advanced and emerging economies. Despite this, there are some promising developments to note.

All economies are making substantial investments in research and development, skills enhancement, and financial accessibility, which are yielding progressively improved results. Some, like Singapore and Ireland, are leaders in specific fields. However, comprehensive indices like the FTRI highlight the significant

variations in the pace of these changes. Consequently, some developing countries, such as China, are catching up with developed ones. However, in general, the gap between developed and most developing nations is expanding.

The escalating global adoption of Information and Communication Technology (ICT), along with the proliferation of services that can be delivered digitally, mirrors the growing trend of the digital economy. This trend is particularly noticeable in developing countries and BRICS nations. Furthermore, the post-pandemic recovery phase has signalled a reduction in the digital divide, indicating that access to digital resources is becoming more widespread and equitable. Despite overall growth, the increasing market share dominance of developed countries, contrasted with the slower but steady progress of developing nations, points to a widening gap in market share and growth potential.

The COVID-19 pandemic significantly disrupted global supply chains, impacting high-technology product exports and creating additional challenges for companies involved in global value chains. While high-technology export data shows a closing gap between upper-middle-income and high-income economies, persistent disparities exist with lower-income groups. Economic shocks, like the dip in 2020, demonstrate that such events can disproportionately affect countries, potentially widening the gap during these periods.

In fact, the findings align with the World Bank's key messages about the state of technology in developing countries (Cirera *et al.*, 2022). It noted that most firms in these regions are significantly distanced from the technology frontier. The transition from industrial revolutions remains incomplete in developing countries, and instances of leapfrogging are rare. Instead, technology upgrading is typically a continuous learning process. Despite these challenges, the adoption of technology is crucial for enhancing productivity, creating jobs, and bolstering economic resilience. This underscores the importance of addressing these gaps and working towards a more technologically equitable future.

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Energy, economic growth, and the balance of power in the global economy

Marek Szczepaniec

Introduction

The progress of civilisation has always depended on the ability to use different sources of energy. Fire, wind, sun, and water used by humans ensured gradual economic growth and an improved quality of life. However, the real leap in civilisation came with the massive use of fossil fuels. Fossil fuels enabled the intensification of production processes and the development of transport in the 19th and 20th centuries.

Another breakthrough came with electrification. Electricity began to reach the farthest corners of countries and found more and more applications. Without electricity, it is difficult to imagine modern civilisation. It ensures the uninterrupted operation of key infrastructure components and provides light, cooling, or heat, depending on the demand; it drives rail transport and – recently increasingly – road transport.

Access to large amounts of relatively cheap energy has become one of the key factors in the competitive advantage not only for individual companies but also for entire countries. Widespread use of energy, access to energy, and energy prices affect all dimensions of human economic activity, be it the cost of production and services, inflation, household purchasing power, consumption, investment, market interest rates, exchange rates, etc. A policy of restricting the growth of energy

supply generates an increase in energy prices, which leads to a slowdown in production processes and an increase in prices in other sectors of the economy. Higher inflation, in turn, contributes to an increase in interest rates, which increases the cost of external financing (loans, leases) and puts an additional burden on all those who previously used credit (companies, households) (Figure 1).

The role of energy in the economy is a very popular subject in science. There are hundreds, if not thousands, of significant publications in this area every year, especially with respect to sustainable growth. However, despite a great deal of scientific activity and changes in economic policy, including energy policy, none of the key problems associated with energy (pollution, rising global CO₂ emissions, energy shortages, and volatile energy prices, including shock events that disrupt not only national economies, but also the entire global economic cycle) have been resolved.

Energy policy and its impact on the balance of power in the global economy have been often described in academic publications, but new developments, rapid changes in the energy market, and international exchanges make the issue topical and requiring constant adjustments and new insights.

The aim of this chapter is to explore and describe the impact of energy on economic growth processes and the balance of power in the global economy.

A comparative analysis of the 10 countries that played the largest role in the global economy in 2022 has been chosen as the research method. The aggregate value of their GDP was USD 67.4 trillion, representing 66.5 per cent of global GDP¹. The baseline period of analysis covers the years between 1990 and 2020 or extends to 2022 if more recent data are available. In terms of the thematic scope of the analyses, the focus is on the following parameters: primary energy consumption, electricity generation, electricity prices, economic growth, exports, innovation, and citizens' wealth.

This study formulates the following three hypotheses for the 10 countries analysed:

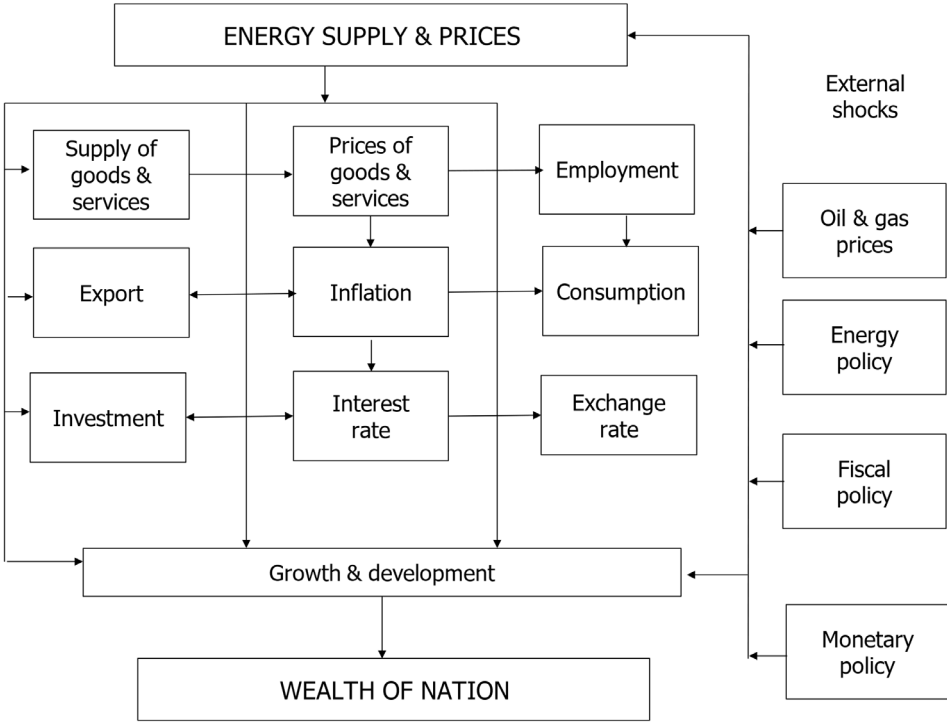
- H1: *There is a positive relationship between a country's share of global energy consumption and its share of global GDP.*
- H2: *There is a positive relationship between a country's share of global electricity production and its share of global GDP.*
- H3: *There is a negative relationship between a country's electricity prices and its share of global GDP.*

1 World Bank (2023), *GDP (current US\$)*, <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD> [19.12.2023].

The rationale for the hypotheses is based on literature studies, the results of fuel and energy sector surveys, and the analysis of macroeconomic indicators.

In the method adopted, the generalisation of results is mainly analytical, but correlation coefficients for key variables have also been counted.

FIGURE 1. The impact of energy supply and prices on the economy.



Source: Internal analysis.

The role of energy in the economy was recognised in the 1970s, when two energy crises occurred. Since then, energy has been accepted as one of the key factors of production, with a multidimensional impact on the functioning of the economy and the international balance of power. Energy security has come to be

associated with stable supplies of relatively cheap oil without the threat of embargoes and price manipulation by exporters².

After the oil crises, the importance of energy policy and related energy security has clearly increased. Energy policy is a deliberate and purposeful activity of a state or group of states to rationally manage energy resources in order to ensure energy security and improve the quality of life of citizens. Energy policy covers such issues as energy sources, energy efficiency, energy prices, energy exports/imports, energy infrastructure, and the environmental impact of the energy sector.

IEA defines energy security as the uninterrupted availability of energy sources at an affordable price (IEA 2024)³. In the long term, energy security is to be ensured by adequate investment in generation capacity, in line with the needs of a growing economy and taking into account the need to protect the environment. According to the World Bank, energy security means ensuring sustainable energy production and consumption at a reasonable price in such a way as to enhance economic growth, reduce poverty, and directly improve people's quality of life by expanding access to advanced energy services⁴. Definitions of energy security have begun to include environmental aspects over time⁵.

After the Second World War, a country's position on the international stage was thought to be determined by three areas (with each area including two factors): the military (personnel and expenditure), industry (energy consumption and iron/steel production), and demography (total population and urban population) (Ray and Singer 1973)⁶. These six indicators make up the Composite Index of National Capability (CINC). In subsequent decades, more attention began to be paid to human capital, information, and groundbreaking technologies. In the USA, the Global Power Index (GPI) was created under the auspices of the National Intelligence Council (NIC). The index included the following

2 Colglazier Jr E., Deese D., 1983, *Energy and security in the 1980s*, "Annual Review of Energy", 8(1), pp. 415–49.

3 IEA (2024), <https://www.iea.org/topics/energy-security>.

4 World Bank (2005), *Energy Security Issues*, The World Bank Group, 2005.

5 UNDP, 2000, United Nations Development Programme, *World energy assessment – energy and challenges of sustainability*, New York.

6 Ray, J.L., Singer, J.D. (1973), *Measuring the Concentration of Power in the International System*, "Sociological Methods & Research", 1(4), pp. 403–437, <https://doi.org/10.1177/004912417300100401>.

areas: nuclear weapons, international trade, research and development (R&D) spending, government revenue, and working age population⁷.

This study measures the global strength of individual countries by relative indicators, such as share of global GDP, share of world trade, share of total patents, and share of total wealth of individuals.

Due to the nature and limited size of this chapter, the focus has been only on the role of energy and innovation, while such issues as military power and the impact of money on international economic processes have been omitted or treated superficially.

4.1. Theoretical background

According to biophysical economics, the production of goods cannot take place without the use of energy (Kummel 1982⁸; Cleveland *et al.* 1984⁹; Kummel and Lindenberg 2014¹⁰). Energy is recognised as a key source of wealth (Hall and Klitgaard 2018¹¹). The use of the energy contained in fossil fuels has enabled rapid economic growth and improved the quality of life of the population.

Energy is treated as an important factor in the classical production function, the Solow Growth Model, and the Cobb–Douglas production function (Wang *et al.* 2011¹²; Pandey and Rastogi 2019¹³; Bekun and Agbola 2019¹⁴;

7 Heim J., Miller B., (2020), *Measuring Power, Power Cycles, and the Risk of Great-Power War in the 21st Century*, RAND Corporation.

8 Kummel, R., 1982, *The impact of energy on industrial growth*, *Energy*, 7, pp. 189–203.

9 Cleveland, C.J., *et al.*, 1984, *Energy and the US economy: a biophysical perspective*, "Science", 225, pp. 890–897.

10 Kummel, R., Lindenberg, D., 2014, *How energy conversion drives economic growth far from the equilibrium of neoclassical economics*, "New Journal of Physics", 16, pp. 1–31.

11 Hall, Ch., Klitgaard, K., 2018, *Energy and the Wealth of Nations. An Introduction to Biophysical Economics*, Springer International Publishing.

12 Wang, Y., *et al.*, 2011, *Energy consumption and economic growth in China: A multivariate causality test*, "Energy Policy", 39, pp. 4399–4406.

13 Pandey, K. K., Rastogi, H., 2019, *Effect of energy consumption and economic growth on environmental degradation in India: A time series modelling*, 10th International Conference in Applied Energy (ICAE 2018), 22–25th August, Hong Kong, China, "Energy Procedia", 158, pp. 4232–4237.

14 Bekun, F.V., Agboola, M. O., 2019, *Electricity consumption and economic growth nexus: evidence from Maki cointegration*, "Engineering Economics", 30(1), pp. 14–23.

Galadima and Aminu 2019¹⁵; Munir *et al.* 2019¹⁶; Akram *et al.* 2020¹⁷; Lee and Chang 2008¹⁸).

In the short-run, AD-SAS equilibrium model, an increase in the supply of energy with relatively low energy prices, leads to a rightward shift of the AS curve and to a change in the position of the equilibrium point reached with higher real GDP (Y) and a lower overall price level (P). In the long-run, AD-LAS equilibrium model, an increase in the supply of resources (including energy) with competitive prices, should contribute to a shift of the LAS curve to the right, resulting in higher GDP and lower inflation.

4.2. Literature review

In the last decade, the unidirectional positive impact of energy consumption on economic growth processes has been confirmed by a number of studies, *e.g.*:

- ✦ Talha *et al.* (2021)¹⁹, Malaysia (1986–2019);
- ✦ Okoye *et al.* (2021)²⁰, Nigeria (1981–2017);
- ✦ Jayasinghe and Selvanathan (2021)²¹, India (1991–2018);
- ✦ Bashir *et al.* (2021)²², Indonesia (1985–2017);

15 Galadima, M.D., Aminu, A.W., 2019, *Nonlinear unit root and nonlinear causality in natural gas – economic growth nexus: Evidence from Nigeria*, "Energy", Volume 190, 1 January 2020, <http://dx.doi.org/10.1016/j.energy.2019.116415>.

16 Munir, Q., *et al.*, 2019, *CO₂ emissions, energy consumption and economic growth in ASEAN-5 countries a cross-sectional dependence approach*, "Energy Economics", <http://dx.doi.org/10.10168/j.eneco.2019.104571>.

17 Akram, R., *et al.*, 2020, *Heterogeneous effects of energy efficiency and renewable energy on economic growth of BRICS countries: A fixed effect panel quantile regression analysis*, "Energy", <http://dx.doi.org/10.1016/j.energy.2020.119019>.

18 Lee, C.C., Chang, C.P., 2008, *Energy consumption and economic growth in Asian economies: a more comprehensive analysis using panel data*, "Resource and Energy Economics", 30, pp. 50–65.

19 Talha, M., *et al.*, 2021, *Impact of oil prices, energy consumption and economic growth on the inflation rate in Malaysia*, "Cuadernos de Economia", 44, pp. 26–32.

20 Okoye, L.U., *et al.*, 2021, *Analysing the energy consumption and economic growth nexus in Nigeria*, "International Journal of Energy Economics and Policy", 11 (2), pp. 378–387.

21 Jayasinghe, M., Selvanathan, E.A., 2021, *Energy consumption, tourism, economic growth and CO₂ emissions nexus in India*, "Journal of the Asia Pacific Economy", 26(2), 361–380, <http://dx.doi.org/10.1080/13547860.2021.1923240>.

22 Bashir, A., *et al.*, 2021, *Relationships between urbanization, economic growth, energy consumption, and CO₂ emissions: Empirical evidence from Indonesia*, Journal of Asian Finance, "Economics and Business", 8(3).

- ✦ Tao *et al.* (2020)²³, China (1990–2016);
- ✦ Güriş and Tiftikçigil (2020)²⁴, Turkey (1990–2015);
- ✦ Zhang *et al.* (2020)²⁵, China (1996–2005);
- ✦ Lin and Wang (2019)²⁶, China (2000–2016);
- ✦ Gozgor *et al.* (2018)²⁷, 29 OECDs, (1990–2013);
- ✦ Ghoshray *et al.* (2018)²⁸, USA (1949–2014);
- ✦ Jiang and Bai (2017)²⁹, China (1987–2007);
- ✦ Ito (2017)³⁰, 42 DCs (2002–2011);
- ✦ Dar (2017)³¹, India (1971–2011);
- ✦ Hamit-Haggar (2016)³², 8SSAs, (1991–2007);
- ✦ Chen *et al.* (2016)³³, 188 countries (1993–2010);
- ✦ Işık & Shahbaz (2015)³⁴, OECD (1980–2010).

Many studies have also found a feedback loop between energy and economic growth demonstrate that increasing energy consumption lead to economic growth, but economic growth also contributes to increasing energy consumption as the population grows richer, *e.g.*:

23 Tao, W., *et al.*, 2020, *Energy consumption in China's marine economic zones – an estimation based on partial linear model*, "Energy", 205, 118028.

24 Güriş, B., Tiftikçigil, B. Y., 2020, *The renewable energy consumption-economic growth nexus in Turkey*, "Social Science Research Journal", 9(3), pp. 105–111.

25 Zhang, J., Zhang, Y., 2020, *Spatial effects of economic growth, energy consumption and environmental pollution in the provinces of China – an empirical study of the spatial econometrics model*, "Sustainable Development", pp. 1–12.

26 Lin, B., Wang, M., 2019, *Possibilities of decoupling for China's energy from consumption economic growth: A temporal spatial analysis*, "Energy", 185, pp. 951–960.

27 Gozgor, G., *et al.*, 2018, *Energy consumption and economic growth: New evidence from the OECD countries*, "Energy", 153, pp. 27–34.

28 Ghoshray, A., *et al.*, 2018, *Re-assessing causality between energy consumption and economic growth*, "PLoS", 13(11), e0205671. <http://dx.doi.org/10.1371/journal.pone.0205671>.

29 Jiang, L., Bai, L., 2017, *Revisiting the granger causality relationship between energy consumption and economic growth in China*, "Sustainability", 9(12), 2299; <https://doi.org/10.3390/su9122299>.

30 Ito, K., 2017, *CO₂ emissions, renewable and non-renewable energy consumption, and economic growth: Evidence from panel data for developing countries*, "International Economics", 151, pp. 1–6.

31 Dar, J. A., Asif, M., 2017, *On causal interaction between carbon emissions, energy consumption and economic growth: An evidence from India*, "International Journal of Ecology & Development", 32(2).

32 Hamit-Haggar, M., 2012, *Greenhouse gas emissions, electricity production and economic growth in different income levels*, "Energy Economics", 34, pp. 358–364.

33 Chen, P., *et al.*, 2016, *Modeling the global relationships among economic growth, energy consumption and CO₂ emissions*, "Renewable and Sustainable Energy Reviews", 65, pp. 420–431.

34 Işık, C., Shahbaz, M., 2015, *Energy consumption and economic growth: A panel data approach to OECD countries*, "International Journal of Energy Science", 5(1), pp. 1–6.

- ✦ Syzdykova *et al.* (2020)³⁵, CIS (1992–2018);
- ✦ Bui (2020)³⁶, Vietnam (1984–2016);
- ✦ Baz *et al.* (2020)³⁷, Pakistan (1971–2014);
- ✦ Zafar *et al.* (2019)³⁸, APEC (1990–2015);
- ✦ Zhang *et al.* (2021)³⁹, 45 BRI (1990–2015);
- ✦ Lawal *et al.* (2020)⁴⁰, Africa (1971–2017);
- ✦ Churchill and Ivanovski (2020)⁴¹, Australia (1990–2005);
- ✦ Ali *et al.* (2020)⁴², Pakistan (1961–2015);
- ✦ Kirikkalelli *et al.* (2018)⁴³, 35 OECDs
- ✦ Al-Mulali and Sab (2018)⁴⁴, GCC (1980–2015),
- ✦ Sarwar *et al.* (2017)⁴⁵, 210 Global (1960–2014);
- ✦ Raza *et al.* (2016)⁴⁶, ASEAN (1980–2010).

35 Syzdykova, A., *et al.*, 2020, *Analysis of the relationship between energy consumption and economic growth in commonwealth independent states*, "International Journal of Energy Economics and Policy", 10(4), pp. 318–324.

36 Bui, X. H., 2020, *An investigation of the causal relationship between energy consumption and economic growth: A case study of Vietnam*, "International Journal of Energy Economics and Policy", 10(5), pp. 415–421.

37 Baz, K., *et al.*, 2020, *Asymmetric impact of energy consumption and economic growth on ecological footprint: Using asymmetric and non-linear approach*, "Science of The Total Environment", 718, pp. 1–10.

38 Zafar, M. W., *et al.*, 2019, *The nexus of renewable and non-renewable energy consumption, trade openness, and CO₂ emissions in the framework of EKC: evidence from emerging economies*, "Environmental Science and Pollution Research", 26(15), pp. 15162–15173.

39 Zhang, H., *et al.*, 2021, *Electricity consumption and economic growth in BRI countries: Panel causality and policy implications*, "Emerging Markets Finance and Trade", 57(3), 859–874. <http://dx.doi.org/10.1080/1540496X.2019.1601551>.

40 Lawal, A. I., *et al.*, 2020, *Examining the linkages between electricity consumption and economic growth in African economies*, "Energy", 208, 118363.

41 Churchill, S. A., Ivanovski, K., 2020, *Electricity consumption and economic growth across Australian states and territories*, "Applied Economics", 52(8), pp. 866–878, <http://dx.doi.org/10.1080/00036846.2019.1659932>.

42 Ali, S., *et al.*, 2020, *Impact of electricity consumption and economic growth: An application of VECM and ANN*, "The Journal of Developing Areas", 54(4).

43 Kirikkalelli, D., *et al.*, 2018, *Panel cointegration: Long run relationship between internet, electricity consumption and economic growth: Evidence from OECDs*, "Investigación Económica", 77(303), 0185–1667.

44 Al-Mulali, U., Che Sab, C. N. B., 2018, *Electricity consumption, CO₂ emission, and economic growth in the Middle East. Energy sources. Part B Economics, planning and policy*, 13(5), pp. 257–263.

45 Sarwar, S., *et al.*, 2017, *Electricity consumption, oil price and economic growth: Global perspective*, "Renewable and Sustainable Energy Reviews", 76, pp. 9–18.

46 Raza, S. A., *et al.*, 2016, *Electricity consumption and economic growth in south*, "South Asia Economic Journal", 17(2), pp. 200–215, <http://dx.doi.org/10.1177/1391561416649721>.

4.3. Analysis of economic data

Primary energy consumption

Primary energy consumption is associated with all economic and livelihood processes. Energy enables the production of goods and services and the movement of goods and people, and it improves the quality of life.

Table 1 shows primary energy consumption, which has increased globally by almost 76 per cent over the past 32 years, from 344 EJ in 1990 to 604 EJ 2022. In 1990, the USA (23.6 per cent) and the Soviet Union (10.5 per cent) were the leaders in primary energy consumption. Over the next 32 years, China has gradually increased its share of primary energy consumption, becoming the world leader in this field. In 2022, China accounted for 26.4 per cent of the world's primary energy, ahead of the USA (15.9 per cent), India (6.0 per cent), and Russia (4.8 per cent). The combined share of the four largest European economies (E4: Germany, United Kingdom, France, and Italy) in primary energy consumption decreased from 11.7 per cent to 5.6 per cent.

TABLE 1. Primary energy: Consumption (Exajoules, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Exajoules)	344	397	509	566	597	604
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	23.6%	24.1%	18.4%	15.6%	15.6%	15.9%
China	8.3%	10.7%	20.6%	26.4%	26.4%	26.4%
Japan	5.5%	5.7%	4.2%	3.0%	3.0%	3.0%
Germany	4.4%	3.6%	2.7%	2.2%	2.1%	2.0%
India	2.4%	3.4%	4.4%	5.6%	5.8%	6.0%
United Kingdom	2.6%	2.4%	1.8%	1.3%	1.2%	1.2%

COUNTRY	1990	2000	2010	2020	2021	2022
France	2.8%	2.8%	2.1%	1.6%	1.6%	1.4%
Russian Federation	10.5%	6.5%	5.5%	5.1%	5.3%	4.8%
Canada	3.1%	3.3%	2.7%	2.4%	2.3%	2.3%
Italy	1.9%	1.9%	1.4%	1.0%	1.1%	1.0%
E4*	11.7%	10.7%	8.0%	6.1%	6.0%	5.6%

* Germany, United Kingdom, France, Italy

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Fossil fuels played a dominant role in the global energy mix in 2022, accounting for a total of 81.8 per cent of primary energy consumed (of which 31.6 per cent – oil, 26.7 per cent – coal, and 23.5 per cent – natural gas). Of the 10 countries analysed, the USA, Russia, and Canada are in the best position. They have abundant fossil fuel resources, which provides them with a high level of energy security and independence. The remaining countries are heavily dependent on imports of energy resources. For China and India, coal is crucial in the energy mix, and they do not intend to give up this raw material in the coming decades.

A different approach is being taken by the EU, which wants to bring about a further reduction in the use of fossil fuels as part of its Fit for 55 policy. The Renewable Energy Directive proposes to increase the overall binding target from the current 32 per cent to a new level of 40 per cent of renewables in the EU energy mix⁴⁷.

⁴⁷ European Commission, 2021, *'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality*, Brussels, 14.7.2021, COM(2021) 550.

TABLE 2. Primary energy: Consumption by fuel (per cent), 2022

COUNTRY	OIL	COAL	NATURAL GAS	RENEWABLES	HYDRO ELECTRIC	NUCLEAR ENERGY
World	31.6%	26.7%	23.5%	7.5%	6.7%	4.0%
United States	37.7%	10.3%	33.1%	8.8%	2.5%	7.6%
China	17.7%	55.5%	8.5%	8.3%	7.7%	2.4%
Japan	37.0%	27.6%	20.3%	8.6%	3.9%	2.6%
Germany	34.6%	18.9%	22.6%	19.9%	1.3%	2.5%
India	27.6%	55.1%	5.7%	5.9%	4.5%	1.1%
United Kingdom	36.5%	2.9%	35.4%	18.7%	0.7%	5.9%
France	34.7%	2.6%	16.5%	9.6%	5.0%	31.6%
Russian Federation	24.4%	11.1%	50.8%	0.3%	6.4%	7.0%
Canada	30.2%	2.7%	31.0%	4.2%	26.4%	5.5%
Italy	40.2%	5.0%	38.2%	12.3%	4.3%	0.0%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Electricity generation

Widespread electrification has driven development in the 20th and 21st centuries. Over the past 32 years, electricity generation has increased by 144 per cent, from 11,961 TWh (1990) to 29,165 TWh (2022).

As electricity is used in all key production and service processes, countries that increase electricity generation are gaining importance in the global economic cycle.

As recently as in 1990, the United States was the world leader in terms of electricity production, accounting for 27 per cent of global electricity production. The USA was ahead of the Soviet Union (9.0 per cent) and Japan (7.4 per cent).

More than three decades later (in 2022), China was clearly in the lead with a share of 30.3 per cent. The USA dropped to the second position (15.6 per cent) and India rose to the third one (6.4 per cent). During that period, the share of Japan and the European countries in global electricity production declined markedly. The share fell from 7.4 per cent to 3.5 per cent for Japan, from 4.6 per cent to 2.0 per cent for Germany, from 3.5 per cent to 1.6 per cent for France, and from 2.7 per cent to 1.1 per cent for the United Kingdom. The combined share of the four largest European economies (E4) in global electricity production decreased from 12.6 per cent to 5.7 per cent. Following the collapse of the USSR, Russia's role in global electricity production also declined (from 9 per cent to 4 per cent).

TABLE 3. Electricity generation (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	11,961	15,564	21,590	26,986	28,520	29,165
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	27.0%	26.0%	20.4%	15.9%	15.4%	15.6%
China	5.2%	8.7%	19.5%	28.8%	29.9%	30.3%
Japan	7.4%	7.1%	5.4%	3.7%	3.6%	3.5%
Germany	4.6%	3.7%	2.9%	2.1%	2.1%	2.0%
India	2.4%	3.7%	4.3%	5.9%	6.0%	6.4%
United Kingdom	2.7%	2.4%	1.8%	1.2%	1.1%	1.1%
France	3.5%	3.5%	2.6%	1.9%	1.9%	1.6%
Russian Federation	9.0%	5.6%	4.8%	4.0%	4.1%	4.0%
Canada	4.0%	3.9%	2.8%	2.4%	2.3%	2.3%
Italy	1.8%	1.8%	1.4%	1.0%	1.0%	1.0%
E4	12.6%	11.4%	8.7%	6.2%	6.1%	5.7%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Coal (35.4 per cent) and gas (22.7 per cent) played the largest role in the global electricity mix in 2022, but hydropower (14.9 per cent) and renewables (14.4 per cent) were also important.

In 2022, the most electricity was generated from coal-fired power plants (India and China), gas-fired power plants (the USA, Russia, Japan, and Italy), hydroelectric power plants (Canada), nuclear power plants (France), and RES-based power plants (Germany and the United Kingdom).

TABLE 4. Electricity generation by fuel (per cent), 2022

COUNTRY	COAL	NATURAL GAS	HYDRO ELECTRIC	NUCLEAR ENERGY	RENEWABLES	OTHER
World	35.4%	22.7%	14.9%	9.2%	14.4%	3.4%
United States	19.9%	39.9%	5.7%	17.9%	15.8%	0.8%
China	61.0%	3.3%	14.7%	4.7%	15.4%	0.8%
Japan	29.9%	30.9%	7.2%	5.0%	14.7%	12.2%
Germany	31.3%	13.8%	3.0%	6.0%	41.0%	4.9%
India	74.3%	2.5%	9.4%	2.5%	11.1%	0.2%
United Kingdom	1.7%	38.4%	1.6%	14.6%	39.7%	3.8%
France	0.7%	10.0%	9.5%	63.0%	14.5%	2.2%
Russian Federation	16.5%	45.8%	16.9%	19.2%	0.6%	1.0%
Canada	5.2%	12.3%	60.4%	13.1%	7.9%	1.1%
Italy	6.1%	54.4%	9.8%	0.0%	25.1%	4.6%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Ways of generating electricity

Coal-fired power plants still play a key role in electricity production. In 2022, they generated 10,317 TWh of electricity, which represented 35.4 per cent of global electricity production.

Over the past 32 years, coal-fired power generation has increased by 131 per cent, from 4460 TWh (1990) to 10,317 TWh (2022). At the same time, China's share of global coal-fired power generation has increased from 9.9 per cent (1990) to 52.3 per cent (2022). In 2023, China has integrated 47 GW of coal-fired power plants into the system. There are further coal-fired power plants under construction with a total capacity of 140 GW and there are still coal-fired power plants with a total capacity of 268 GW in the announced, pre-permit, and permitted stages⁴⁸.

India's share of global coal-fired power generation has also increased markedly, from 4.3 per cent to 13.4 per cent, and more coal-fired power plants with a total capacity of almost 31 GW are under construction. It is worth mentioning that further coal-fired power plants are also under construction in other Asian countries, *i.e.*, Indonesia (9.4 GW), Vietnam (3.9 GW), Bangladesh (3.9 GW), and South Korea (2.1 GW).

Germany and the United Kingdom have opted for accelerated decarbonisation, thus depriving themselves of an important energy source (or reducing its role), which has had an impact on rising energy prices. The combined share of the four largest European economies in coal-fired power generation has fallen from 13.2 per cent to just 2.1 per cent.

Gas is regarded as a better energy carrier than coal due to its lower CO₂ emissions. Over the past 32 years, gas-fired power generation has increased by 270 per cent, from 1,790 TWh (1990) to 6,631 TWh (2022).

By investing in the extraction of gas from unconventional deposits, the USA has become a world leader in both natural gas production and gas-fired power generation, with a 27.4 per cent share of global gas-fired power generation. The abundance and low price of natural gas have enabled the USA to gradually move away from coal.

In Russia, the situation is different. The country has the world's largest identified deposits of natural gas, but its share of global gas-fired power generation has

48 Global Energy Monitor, 2024, *Boom and Bust Coal 2024*.

TABLE 5. Electricity generation from coal (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	4460	5992	8640	9472	10211	10317
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	38.7%	35.5%	23.1%	8.9%	9.6%	8.8%
China	9.9%	17.7%	37.4%	52.0%	52.2%	52.3%
Japan	2.7%	3.9%	3.6%	3.1%	3.0%	3.0%
Germany	7.0%	4.9%	3.0%	1.4%	1.6%	1.8%
India	4.3%	6.5%	7.4%	12.1%	12.5%	13.4%
United Kingdom	4.6%	2.0%	1.2%	0.1%	0.1%	0.1%
France	0.8%	0.5%	0.3%	0.0%	0.0%	0.0%
Russian Federation	3.5%	2.9%	1.9%	1.8%	1.8%	1.9%
Canada	1.8%	1.9%	1.0%	0.4%	0.3%	0.3%
Italy	0.8%	0.5%	0.5%	0.2%	0.2%	0.2%
E4	13.2%	7.9%	5.0%	1.7%	1.9%	2.1%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

declined from 13.4 per cent in 2000 to 8.1 per cent in 2022. Gas has been, and still is, treated in Russia as an important export commodity, a source of budget revenue, and a factor that can influence the political and economic situation in other countries (especially European ones).

Energy policy in Europe has led to a dependence on a single gas supplier, Russia. The largest four European economies which imported gas from Russia were hit hard by supply constraints and high gas prices, which was particularly evident after Russia's attack on Ukraine. E4's share of global gas-fired power generation declined from 11.2 per cent in 2000 to 6.2 per cent in 2022.

China has gradually increased its share of gas use for electricity generation from 0.2 per cent in 1990 to 4.4 per cent in 2022. The country is investing heavily in geological research and contracting increasing gas supplies from Russia.

TABLE 6. Electricity generation from gas (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	1,790	2,773	4,884	6,418	6,566	6,631
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	22.4%	23.3%	21.7%	27.3%	25.9%	27.4%
China	0.2%	0.2%	1.6%	3.9%	4.4%	4.4%
Japan	9.7%	9.2%	6.6%	5.5%	5.0%	4.8%
Germany	2.0%	1.8%	1.8%	1.5%	1.4%	1.2%
India	0.6%	2.0%	2.4%	1.2%	0.9%	0.7%
United Kingdom	0.3%	5.3%	3.6%	1.7%	1.9%	1.9%
France	0.2%	0.4%	0.5%	0.6%	0.5%	0.7%
Russian Federation	28.6%	13.4%	10.7%	7.3%	7.9%	8.1%
Canada	0.5%	1.3%	1.1%	1.1%	1.2%	1.2%
Italy	2.2%	3.7%	3.1%	2.1%	2.2%	2.4%
E4	4.7%	11.2%	9.0%	5.9%	6.0%	6.2%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Hydroelectric power plants rank third among the key means of electricity generation. Over the past 32 years, hydroelectric power generation has increased by 101 per cent, from 2,159 TWh (1990) to 4,334 TWh (2022).

China also ranks first in this area. In 2022, it accounted for 30.1 per cent of hydroelectric power generation, compared to only 5.9 per cent in 1990. Several large hydropower plants have been built in China, including Three Gorges Dam (22.5 GW), which is the world's largest power station, Baihetan Dam (16.0 GW), and Xiluodu Dam (13.9 GW). However, the role of the USA, Japan, and European countries (E4) in hydropower is gradually declining.

TABLE 7. Hydroelectricity: Generation (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	2,159	2,647	3,430	4,359	4,289	4,334
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	13.5%	10.3%	7.5%	6.5%	5.8%	6.0%
China	5.9%	8.4%	20.7%	30.3%	30.3%	30.1%
Japan	4.0%	3.2%	2.6%	1.8%	1.9%	1.7%
Germany	0.8%	0.9%	0.6%	0.4%	0.5%	0.4%
India	3.1%	2.9%	3.2%	3.8%	3.7%	4.0%
United Kingdom	0.2%	0.2%	0.1%	0.2%	0.1%	0.1%
France	2.5%	2.5%	1.8%	1.4%	1.4%	1.0%
Russian Federation	7.7%	6.2%	4.9%	4.9%	5.0%	4.6%
Canada	13.7%	13.5%	10.2%	8.9%	8.9%	9.2%
Italy	1.5%	1.7%	1.5%	1.1%	1.1%	0.6%
E4	5.0%	5.3%	4.0%	3.1%	3.1%	2.1%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

The fourth key source of electricity is nuclear power, which, unlike RES, provides a stable supply of electricity. However, over the past 32 years, nuclear power generation has only increased by 34 per cent, from 2,001 TWh (1990) to 2,679 TWh (2022). The Fukushima disaster caused a decline in the importance of this mode of electricity generation in the global energy mix and some countries, such as Japan and Germany, have begun to move away from nuclear power for safety reasons.

The United States remains the clear leader in nuclear power (in 2022) with a 30.3 per cent share, ahead of China, which, however, is increasing its share of nuclear power generation from decade to decade (15.6 per cent), followed by France (11.0 per cent) and Russia (8.4 per cent).

TABLE 8. Nuclear: Generation (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	2,001	2,581	2,768	2,689	2,803	2,679
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	30.4%	30.8%	30.7%	30.9%	29.3%	30.3%
China	0.0%	0.6%	2.7%	13.6%	14.5%	15.6%
Japan	9.7%	12.4%	10.6%	1.6%	2.2%	1.9%
Germany	7.6%	6.6%	5.1%	2.4%	2.5%	1.3%
India	0.3%	0.6%	0.8%	1.7%	1.6%	1.7%
United Kingdom	3.3%	3.3%	2.2%	1.9%	1.6%	1.8%
France	15.7%	16.1%	15.5%	13.2%	13.5%	11.0%
Russian Federation	5.9%	5.1%	6.2%	8.0%	7.9%	8.4%
Canada	3.6%	2.8%	3.3%	3.6%	3.3%	3.2%
Italy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
E4	26.6%	26.0%	22.8%	17.5%	17.6%	14.1%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Among renewable energy sources, wind power, in addition to hydropower, plays a key role. Over the past 32 years, wind power generation has increased 526 times, from 4 TWh (1990) to 2,105 TWh (2022).

In the early days of wind power development, it was the United States and Germany that led the way, introducing groundbreaking technologies and investing the most in this type of energy. China was a late entrant into this sector of power industry but had a significant position in 2010 (14.3 per cent) to become the clear leader in 2022, with a 36.2 per cent share of global wind power generation.

TABLE 9. Renewables: Generation – wind (Terawatt-hours)

COUNTRY	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	4	31	346	1,594	1,854	2,105
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	77.5%	18.0%	27.6%	21.4%	20.6%	20.9%
China	0.0%	1.9%	14.3%	29.3%	35.4%	36.2%
Japan	0.0%	0.3%	1.1%	0.5%	0.4%	0.4%
Germany	2.0%	30.2%	11.1%	8.3%	6.2%	6.0%
India	0.0%	5.0%	5.6%	3.8%	3.7%	3.3%
United Kingdom	0.0%	3.0%	3.0%	4.7%	3.5%	3.8%
France	0.0%	0.0%	2.9%	2.5%	2.0%	1.8%
Russian Federation	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%
Canada	0.0%	0.8%	2.5%	2.2%	1.9%	1.8%
Italy	0.0%	1.8%	2.6%	1.2%	1.1%	1.0%
E4	2.0%	35.0%	19.6%	16.7%	12.8%	12.6%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

In recent years, solar power has seen the greatest growth rate, with the amount of electricity generated by photovoltaic devices increasing 25-fold in just one decade (2010–2020) and 3,307-fold in the last 32 years, from 0.4 TWh (1990) to 1,323 TWh (2022).

The countries that pioneered the development of this sector, the United States, Japan, and Germany, have been overtaken by China, which is also a clear leader in this field, with a 32.3 per cent share of the global photovoltaic panel electricity generation market in 2022.

TABLE 10. Renewables: Generation – solar (Terawatt-hours)

Country	1990	2000	2010	2020	2021	2022
World (Terawatt-hours)	0.4	1	34	854	1,059	1,323
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	95.5%	48.9%	8.9%	15.5%	15.7%	15.6%
China	0.5%	2.1%	2.1%	30.6%	30.9%	32.3%
Japan	0.3%	32.5%	11.7%	8.8%	8.7%	7.7%
Germany	0.3%	0.0%	35.3%	5.8%	4.7%	4.6%
India	0.0%	0.7%	0.3%	6.9%	6.4%	7.2%
United Kingdom	0.0%	0.1%	0.1%	1.5%	1.1%	1.1%
France	0.0%	0.5%	1.8%	1.5%	1.4%	1.5%
Russian Federation	0.0%	0.0%	0.0%	0.2%	0.2%	0.2%
Canada	0.0%	1.5%	0.8%	0.5%	0.5%	0.5%
Italy	1.0%	1.7%	5.6%	2.9%	2.4%	2.1%
E4	1.3%	2.3%	42.8%	11.7%	9.6%	9.3%

Source: Energy Institute, *Statistical Review of World Energy, 2023*, <https://www.energyinst.org/statistical-review> [19.12.2023].

Despite the spectacular growth of RES-based power generation in recent years, the total amount of electricity generated by wind power plants (2,105 TWh) and solar power plants (1,323 TWh) in 2022 was three times lower than that generated by coal-fired power plants (10,317 TWh).

The facts given below provide an apt summary of the above discussion. China currently plays the largest role in energy production and consumption and has the largest share of total electricity generation as well as of coal, hydro, wind, and solar power generation. The United States still remains the leader in nuclear and gas power, but its importance in total primary energy consumption and electricity generation is gradually declining. The importance of Japan and the largest European countries (E4) in the world energy sector is clearly declining.

4.4. Electricity prices

Countries with a large amount of the production factor, *i.e.*, energy, have the potential to increase their production of goods and services, but the price of electricity also plays an important role. In this area, China, Russia, and Canada have a clear competitive advantage over the other countries (Table 19). The USA and India have business electricity prices that are clearly higher than those of the three countries mentioned above, but such countries as Italy, the United Kingdom, Germany, and Japan have the highest prices. This has a negative impact on the international competitiveness of these economies.

The correlation coefficient between electricity prices in the 10 countries analysed and their share of global GDP measured at current exchange rates was -0.35 in 2022. The correlation coefficient between electricity prices in the 10 countries analysed and their share of world PPP GDP (taking into account varying purchasing power parity) was -0.45 in 2022. It is important to note that the analysis includes electricity prices from 2023 and not 2022 because 2022 was an atypical year, with a price shock related, among others, to the war in Ukraine (*e.g.*, in December 2022, business electricity prices in Germany amounted to USD 0.91/kWh).

TABLE 11. Electricity prices USD / kWh, June 2023

COUNTRY	ELECTRICITY PRICES FOR HOUSEHOLDS, USD/KWH	ELECTRICITY PRICES FOR BUSINESS, USD/KWH
United States	0.166	0.147
China	0.078	0.090
Japan	0.230	0.276
Germany	0.399	0.289
India	0.079	0.131
United Kingdom	0.443	0.408
France	0.257	0.207
Russian Federation	0.066	0.097
Canada	0.123	0.103
Italy	0.431	0.582

Source: https://www.globalpetrolprices.com/electricity_prices/ [30.01.2024].

Economic growth and share of global GDP

Energy (including electricity) is used in large part in machines and equipment that are more efficient than simple human labour. Furthermore, with the low price of energy, goods can be produced more cheaply and at the same time services can be provided more cheaply, which makes them more attractive on the global market. In addition, the low price of electricity for households inhibits consumer inflation, which translates into high domestic demand.

One of the key indicators showing the global strength of an economy is GDP. Large amounts of energy and its relatively low prices influence the rate of economic growth, which in many countries is driven by industrial production, infrastructure construction, housing construction, and exports.

Of the group of 10 countries studied, the highest average GDP growth rates between 1990 and 2022 were recorded by countries increasing their energy generation capacity while having relatively low energy prices, *i.e.*, China (8.9 per cent), India (6.0 per cent), and the United States (2.4 per cent). Given the average growth rate for the global economy (2.9 per cent), it can be said that China and India have been key drivers of global economic growth in recent decades.

Very low growth rates in the period studied were recorded in Italy (0.8 per cent) and Japan (0.9 per cent), which do not have an adequate raw material base in terms of energy carriers. The low average growth rate in Russia over the period studied is mainly attributable to the crisis decade 1990–1999. In the following decade, with rising energy commodity prices, the rate of economic growth was high in the country.

TABLE 12. GDP growth (average annual %)

COUNTRY	1990–1999	2000–2009	2010–2019	1990–2022
World	2.8%	3.0%	3.2%	2.9%
United States	3.2%	1.9%	2.3%	2.4%
China	10.0%	10.4%	7.7%	8.9%
Japan	1.5%	0.5%	1.2%	0.9%
Germany	2.2%	0.8%	2.0%	1.5%
India	5.8%	6.3%	6.6%	6.0%
United Kingdom	2.3%	1.7%	2.0%	1.9%
France	2.0%	1.5%	1.4%	1.5%
Russian Federation	-4.9%	5.5%	2.0%	0.8%
Canada	2.4%	2.1%	2.3%	2.1%
Italy	1.5%	0.5%	0.3%	0.8%

Source: World Bank (2023), *GDP growth (annual %)*, <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG> [5.01.2024].

In terms of current exchange rates, the United States is still the economic leader with a 25.1 per cent share of global GDP, but this share has clearly declined since 2000, when it was 30.2 per cent. Over the past 32 years, China's importance in the world economy has clearly increased (from 1.7 per cent to 17.7 per cent), with the decrease in the importance of the following countries: Japan (from 13.9 per cent to 4.2 per cent), Germany (from 7.7 per cent to 4.0 per cent), the United Kingdom (from 4.8 per cent to 3.0 per cent), and France (from 5.5 per cent to 2.7 per cent). India's importance in the global economy has slowly increased from 1.4 per cent in 1990 to 3.4 per cent in 2022.

The correlation coefficients between the share of the 10 countries analysed in world energy consumption and their share in global GDP measured at current exchange rates range from 0.76 (2010) to 0.86 (2021) in each year. The correlation coefficients between the share of the 10 countries analysed in world electricity production and their share in global GDP measured at current exchange rates range from 0.81 (2022) to 0.90 (2000) in each year.

TABLE 13. GDP (bn current US\$, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (bn USD)	22,935	33,899	66,707	85,258	97,530	101,326
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	26.0%	30.2%	22.6%	24.7%	23.9%	25.1%
China	1.7%	3.6%	9.1%	17.2%	18.3%	17.7%
Japan	13.9%	14.7%	8.6%	5.9%	5.1%	4.2%
Germany	7.7%	5.7%	5.1%	4.6%	4.4%	4.0%
India	1.4%	1.4%	2.5%	3.1%	3.2%	3.4%
United Kingdom	4.8%	4.9%	3.7%	3.2%	3.2%	3.0%
France	5.5%	4.0%	4.0%	3.1%	3.0%	2.7%

COUNTRY	1990	2000	2010	2020	2021	2022
Russian Federation	2.3%	0.8%	2.3%	1.8%	1.9%	2.2%
Canada	2.6%	2.2%	2.4%	1.9%	2.1%	2.1%
Italy	5.2%	3.4%	3.2%	2.2%	2.2%	2.0%
E4	23.2%	18.0%	16.0%	13.1%	12.8%	11.7%

Source: World Bank (2023), *GDP (current US\$)*, <https://data.worldbank.org/indicator/NY.GDP.MKTP.CD> [19.12.2023].

Even greater changes in the global balance of power can be seen if GDP with purchasing power parity (PPP) is taken into account. In terms of PPP, China is the world leader in the GDP category (with its share increasing from 3.8 per cent to 18.4 per cent between 1990 and 2022), with the United States falling to second place (from 20.2 per cent to 15.5 per cent). Table 14 shows an increase in the importance of India (from 3.6 per cent to 7.2 per cent) and a progressive decline in the role of Japan, Germany, Italy, France, and the United Kingdom.

The correlation coefficients between the share of the 10 countries analysed in world energy consumption and their share in world PPP GDP (taking into account varying purchasing power parity) range from 0.89 (1990) to 0.97 (2022) in each year. The correlation coefficients between the share of the 10 countries analysed in world electricity production and their share of global PPP GDP (taking into account varying purchasing power parity) range from 0.95 (1990) to 0.98 (2010) in each year.

TABLE 14. GDP, PPP (current international \$)

COUNTRY	1990	2000	2010	2020	2021	2022
World (bn USD)	29,504	49,255	89,840	134,748	148,465	164,533
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	20.2%	20.8%	16.8%	15.6%	15.7%	15.5%
China	3.8%	7.5%	13.8%	18.0%	18.5%	18.4%
Japan	8.3%	7.0%	5.0%	3.9%	3.6%	3.5%
Germany	5.2%	4.5%	3.5%	3.5%	3.3%	3.2%
India	3.6%	4.5%	5.8%	6.8%	7.0%	7.2%
United Kingdom	3.3%	3.2%	2.5%	2.3%	2.3%	2.2%
France	3.5%	3.2%	2.6%	2.4%	2.3%	2.3%
Russian Federation	4.0%	2.0%	3.3%	3.3%	3.3%	3.2%
Canada	1.9%	1.8%	1.5%	1.3%	1.4%	1.4%
Italy	3.6%	3.1%	2.3%	1.9%	1.9%	1.9%
E4	15.6%	14.0%	10.9%	10.1%	9.8%	9.6%

Source: World Bank (2023), *GDP, PPP (current international \$)*, <https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD> [19.12.2023].

One of the indicators of a country's strength on the international stage is its steel production. Steel is one of the most important materials. It has a wide range of applications, from infrastructure construction, transport, and packaging to engineering, automotive, and precision industries. However, the production of steel requires large amounts of energy, and its price is important. China is the undisputed leader in crude steel production, with a 54.0 per cent share of the global market in 2022.

TABLE 15. Crude steel production (in million tonnes, share), 2022

COUNTRY	CRUDE STEEL PRODUCTION, 2022 (MILLION TONNES)	%
World	1885.4	100.0%
United States	80.5	4.3%
China	1018.0	54.0%
Japan	89.2	4.7%
Germany	36.8	2.0%
India	125.3	6.6%
United Kingdom	6.0	0.3%
France	12.1	0.6%
Russian Federation	71.5	3.8%
Canada	12.1	0.6%
Italy	21.6	1.1%
E4	76.5	4.1%

Source: World Steel Association (2023), *2023 World Steel in Figures*.

4.5. Innovation

Abundant energy resources or the production of large amounts of electricity alone do not guarantee economic growth and development, as evidenced by the examples of Venezuela or Equatorial Guinea and, to a lesser extent, Russia. Energy is only transformed into wealth when it is used in important production processes and when a large part of the added value generated by this energy stays in the country. Even a developed heavy industry is not enough if the country is unable to produce adequate consumer goods.

The best combination is a mix of energy with productive capital and intellectual capital (knowledge, experience, and technology). This ensures the production of high-tech products with original design and relatively low prices. One of the indicators showing the level of intellectual capital in a country and its associated innovation is patent activity. A high number of patent applications and patents obtained is evidence that a country is making technical progress and improving its competitive position.

Companies from the USA, Western Europe, Japan, and South Korea viewed China as a good place for foreign investment because of cheap energy, relatively low labour costs, and a growing domestic market. However, according to the Global Value Chain theory and practice, the vast majority of value added went to highly developed countries^{49,50}. To improve their position in global value chains, the Chinese invested in new sectors of the economy, supporting scientific research and their own innovative enterprises, which resulted in the launch of many high-tech products.

Over the past 32 years, there has been a reshuffling of the top of the most innovative economies. China has come out on top in terms of patent applications filed and patents received. China's share of total patent applications has increased from just 1.0 per cent in 1990 to 43.8 per cent in 2022. It is worth mentioning that China has a high level of patent activity in the energy industry, accounting for 51.6 per cent of patent applications in solar energy, 50.7 per cent in geothermal energy, 38.9 per cent in wind energy, and 37.0 per cent in hydropower.

In 2000, the USA accounted for the largest share of patent applications (30.5 per cent), but in the following years the country's share of global patent activity gradually declined to 17.7 per cent in 2022. Table 16 shows a progressive decline in the role of Japan, Germany, Italy, France, and the United Kingdom in global patent activity.

The correlation coefficients between the share of the 10 countries analysed in the total number of patent applications filed and their share of PPP GDP (taking into account varying purchasing power parity) range from 0.71 (1990) to 0.94 (2020) in each year.

49 OECD, 2011, *Global Value Chains: Preliminary Evidence and Policy Issues*.

50 Gereffi, G., Fernandez-Stark, K., 2016, *Global Value Analysis: A Primer*. Center on Globalization, Governance & Competitiveness (Duke University), 2nd Edition, pp. 1–34.

TABLE 16. Patent applications (number, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (number)	406,582	516,800	915,200	1,596,900	1,754,900	1,823,200
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	22.2%	30.5%	24.0%	22.0%	18.7%	17.7%
China	1.0%	2.5%	14.8%	33.2%	39.7%	43.8%
Japan	14.6%	24.4%	24.3%	11.2%	10.5%	11.0%
Germany	4.7%	2.8%	1.5%	1.1%	1.2%	1.3%
India	0.4%	0.2%	0.8%	1.7%	1.8%	1.7%
United Kingdom	2.3%	1.6%	0.6%	0.6%	0.6%	0.6%
France	3.2%	2.2%	1.1%	0.8%	0.9%	0.7%
Russian Federation	20.8%	3.4%	3.3%	1.8%	1.3%	1.3%
Canada	3.5%	2.3%	2.1%	1.3%	1.3%	1.0%
Italy	3.0%	1.0%	1.8%	0.6%	0.4%	0.4%
E4	13.2%	7.6%	5.0%	3.1%	3.1%	3.0%

Source: WIPO (2024), https://www.wipo.int/ipstats/en/statistics/country_profile/ [21.02.2024].

The high patent activity referred to above has resulted in China's share of the total number of patents held increasing from just 1.0 per cent in 1990 to 46.8 per cent in 2022. There has been a clear decline in the share of Japan, E4, and Russia in the global number of patents obtained.

The correlation coefficients between the share of the 10 countries analysed in the total number of patents held and their share of PPP GDP (taking into account the varying purchasing power parity) range from 0.53 (1990) to 0.90 (2020) in each year.

TABLE 17. Patent grants (number, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (number)	997,500	1,377,600	1,997,500	3,282,200	3,400,500	3,457,400
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	17.2%	21.5%	24.5%	18.2%	17.4%	17.2%
China	1.0%	3.8%	19.6%	45.6%	46.6%	46.8%
Japan	36.9%	31.7%	17.3%	8.8%	8.5%	8.4%
Germany	3.9%	4.5%	3.0%	1.9%	1.7%	1.7%
India	0.4%	0.6%	2.0%	1.7%	1.8%	2.2%
United Kingdom	2.8%	2.4%	1.1%	0.6%	0.6%	0.6%
France	1.7%	1.3%	0.8%	0.4%	0.4%	0.4%
Russian Federation	11.6%	2.3%	2.1%	1.1%	0.9%	0.8%
Canada	2.7%	2.9%	1.8%	1.1%	1.1%	1.1%
Italy	0.9%	0.7%	0.5%	0.3%	0.3%	0.3%
E4	9.3%	8.9%	5.4%	3.2%	3.0%	3.0%

Source: WIPO (2024), https://www.wipo.int/ipstats/en/statistics/country_profile/ [21.02.2024].

4.6. Merchandise exports

One of the key indicators showing a country's global strength is its share of merchandise exports, and in particular its share of manufactured goods exports. Countries with high amounts of cheap energy, extensive productive capital, and technological innovation can produce and offer, at competitive prices, more attractive products, both for consumption and investment, which gives them an advantage in the international market. There have been major changes in this area over

the past 32 years. Between 1990 and 2010, China went from being an exporter with a relatively small share of the world market (1.8 per cent in 1990) to the clear leader (10.3 per cent in 2010) to successively increase its share in the following years (to 15.0 per cent in 2021). During the period analysed, the role of Germany, the USA, Japan, France, the United Kingdom, and Italy in global exports declined markedly.

The correlation coefficients between the share of the 10 countries analysed in world energy consumption and their share of global commodity exports range from 0.65 (2000) to 0.90 (2022) in each year and increase throughout the period analysed.

The correlation coefficients between the share of the 10 countries analysed in world electricity production and their share of global commodity exports range from 0.71 (2000) to 0.91 (2022) in each year and also increase throughout the period analysed.

TABLE 18. Total merchandise exports – annual (bn US dollar, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (bn USD)	3,490	6,454	15,302	17,653	22,366	24,926
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	11.3%	12.1%	8.4%	8.1%	7.8%	8.3%
China	1.8%	3.9%	10.3%	14.7%	15.0%	14.4%
Japan	8.2%	7.4%	5.0%	3.6%	3.4%	3.0%
Germany	12.1%	8.5%	8.2%	7.8%	7.3%	6.7%
India	0.5%	0.7%	1.5%	1.6%	1.8%	1.8%
United Kingdom	5.3%	4.4%	2.7%	2.3%	2.1%	2.1%
France	6.2%	5.1%	3.4%	2.8%	2.6%	2.5%
Russian Federation	..	1.6%	2.6%	1.9%	2.2%	2.4%
Canada	3.7%	4.3%	2.5%	2.2%	2.3%	2.4%

COUNTRY	1990	2000	2010	2020	2021	2022
Italy	4.9%	3.7%	2.9%	2.8%	2.8%	2.6%
E4	28.5%	21.7%	17.2%	15.7%	14.8%	13.9%

Source: WTO (2023), *Merchandise exports by product group*, <https://stats.wto.org/> [19.12.2023].

The shift in favour of China in terms of exports of manufactured goods is even more pronounced. The country's share of industrial goods exports has increased from 1.9 per cent in 1990 to 21.2 per cent in 2022. In contrast, the share of such countries as Germany, the USA, Japan, France, Italy, and the United Kingdom in global exports of industrial goods has declined.

The correlation coefficients between the share of the 10 countries analysed in world energy consumption and their share of global exports of manufactured goods range from 0.60 (2000) to 0.85 (2022) in each year and increase throughout the period analysed.

The correlation coefficients between the share of the 10 countries analysed in world electricity production and their share of global exports of manufactured goods range from 0.66 (2000) to 0.88 (2022) in each year and also increase throughout the period analysed.

TABLE 19. Total merchandise exports SI3_AGG – MA – Manufactures – annual (bn US dollar, share)

COUNTRY	1990	2000	2010	2020	2021	2022
World (bn USD)	2,391	4,690	9,989	12,142	14,881	15,720
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
United States	12.1%	13.8%	8.7%	7.5%	7.3%	7.6%
China	1.9%	4.7%	14.8%	19.9%	21.1%	21.2%
Japan	11.5%	9.6%	6.8%	4.5%	4.4%	4.0%
Germany	15.7%	10.3%	10.8%	9.9%	9.5%	8.9%

COUNTRY	1990	2000	2010	2020	2021	2022
India	0.5%	0.7%	1.4%	1.6%	1.8%	1.8%
United Kingdom	6.1%	4.7%	2.9%	2.3%	2.0%	2.0%
France	6.7%	5.8%	4.0%	3.2%	3.0%	2.9%
Russian Federation	..	0.5%	0.6%	0.6%	0.7%	0.6%
Canada	3.1%	3.7%	1.9%	1.5%	1.4%	1.5%
Italy	6.2%	4.5%	3.7%	3.3%	3.3%	3.3%
E4	34.7%	25.3%	21.4%	18.7%	17.8%	17.1%

Source: WTO (2023), *Merchandise exports by product group – S13_AGG – MA – Manufactures*, <https://stats.wto.org/> [19.12.2023].

4.7. The wealth of nations

According to World Bank research, the wealth of nations is influenced by human capital, productive capital, natural capital, and net foreign assets⁵¹. According to the adopted approach, in which human capital, valued using the income-based valuation method, plays a key role, the countries analysed had the following share of global wealth in 2017: USA (27.4 per cent), China (12.9 per cent), Japan (6.4 per cent), Germany (5.2 per cent), France (3.7 per cent), United Kingdom (3.7 per cent), Canada (3.2 per cent), Russia (2.4 per cent), Italy (2.3 per cent), and India (2.1 per cent).

In another view, wealth is equated with the assets of citizens. The United States has the greatest wealth with a 30.8 per cent share of global assets, but there is a gradual decline in its share (from 36.9 per cent in 2000). The situation is similar for Japan (down from 16.5 per cent to 5.0 per cent) and the four European countries (down from 19.5 per cent to 13.2 per cent). The data in Table 20 show a clear increase in China's share of global wealth from 3.1 per cent (2000) to 18.6 per cent (2022) and a gradual increase in India's importance from 1.3 per cent (2000) to 3.4 per cent (2022).

51 World Bank (2018), *The changing wealth of nations 2018: building a sustainable future*.

The correlation coefficients between the share of the 10 countries analysed in world energy consumption and their share in global wealth range from 0.71 (2010) to 0.84 (2000) in each year. The correlation coefficients between the share of the 10 countries analysed in world electricity production and their share of global wealth range from 0.74 (2021) to 0.90 (2000) in each year.

TABLE 20. Wealth estimates by country (bn USD, share)

COUNTRY	2000	2010	2020	2021	2022
World (bn USD)	117,844	251,885	422,117	463,567	454,385
World (%)	100.0%	100.0%	100.0%	100.0%	100.0%
United States	36.9%	25.7%	29.9%	31.5%	30.8%
China	3.1%	10.1%	17.5%	18.4%	18.6%
Japan	16.5%	11.4%	6.5%	5.5%	5.0%
Germany	5.2%	4.7%	4.3%	3.8%	3.8%
India	1.3%	2.7%	3.0%	3.1%	3.4%
United Kingdom	5.6%	4.5%	3.7%	3.5%	3.5%
France	4.0%	5.4%	3.9%	3.5%	3.5%
Russian Federation	0.3%	0.9%	0.8%	0.8%	1.0%
Canada	2.2%	2.7%	2.5%	2.7%	2.5%
Italy	4.7%	4.6%	2.9%	2.5%	2.4%
E4	19.5%	19.2%	14.8%	13.3%	13.2%

Source: Credit Suisse Research Institute (2010), *Global wealth databook 2010*, UBS Research Institute (2023), *Global wealth databook 2023*, [19.12.2023].

According to an analysis by Swiss bank UBS, in 2022 China had the largest population (168.4 million) of people with wealth between USD 100,000 and

USD 1 million (24.0 per cent of the global adult population with such wealth). The USA remained the leader, with a share of 38.2 per cent, in the wealth group above USD 1 million.

TABLE 21. Membership of top wealth groups for selected markets, 2022

MARKET/ REGION	2010				2022			
	USD 100,000 – 1 MILLION		OVER USD 1 MILLION		USD 100,000 – 1 MILLION		OVER USD 1 MILLION	
	NUMBER OF ADULTS (THOUSANDS)	%	NUMBER OF ADULTS (THOUSANDS)	%	NUMBER OF ADULTS (THOUSANDS)	%	NUMBER OF ADULTS (THOUSANDS)	%
World	359,810	100	24,546	100	701,064	100	59,391	100
United States	83,622	23.2	9,940	40.5	132,407	18.9	22,710	38.2
China	17,465	4.9	805	3.3	168,421	24.0	6,231	10.5
Japan	53,246	14.8	2,380	9.7	52,261	7.5	2,757	4.6
Germany	27,931	7.8	1,040	4.3	29,862	4.3	2,627	4.4
India	2,940	0.8	170	0.7	20,114	2.9	849	1.4
United Kingdom	21,869	6.1	1,231	5.1	29,271	4.2	2,556	4.3
France	18,681	5.2	2,225	9.1	29,386	4.2	2,821	4.7
Russian Federation	1,235	0.3	10	0.0	4,437	0.6	408	0.7
Canada	12,709	3.5	905	3.7	16,923	2.4	2,032	3.4
Italy	27,016	7.5	1,415	5.8	25,815	3.7	1,335	2.2
E4	95,497	26.6	5,911	24.3	114,334	16.4	9,339	15.6

Source: Credit Suisse Research Institute (2015), *Global Wealth Databook 2015* and UBS Research Institute (2023), *Global Wealth Databook 2023*.

Thanks to rapid economic development, driven by cheap energy and foreign investment, China has built the world's largest (by volume) middle class. Middle class generates strong demand for cars, smartphones, and other consumer products, which in turn drives product innovation. Now, China is not only the “factory of the world” but also the largest market. China's share of global new car production is 33.5 per cent and its share of new car registrations is 30.8 per cent.

TABLE 22. Car production (in units) and new car registrations (in units)

COUNTRY	CAR PRODUCTION, 2023 (UNITS)	%	NEW CAR REGISTRATIONS, 2023 (UNITS)	%
World	75,615,450	100.0%	72,457,199	100.0%
United States	7,629,525	10.1%	12,327,829	17.0%
China	25,347,593	33.5%	22,320,061	30.8%
Japan	7,734,465	10.2%	3,989,608	5.5%
Germany	3,959,322	5.2%	2,844,609	3.9%
India	4,669,500	6.2%	4,176,522	5.8%
United Kingdom	901,893	1.2%	1,903,054	2.6%
France	959,404	1.3%	1,774,723	2.4%
Russian Federation	491	0.0%	1,015,387	1.4%
Canada	n/a	n/a	n/a	n/a
Italy	542,218	0.7%	1,565,331	2.2%
E4	6,362,837	8.4%	8,087,717	11.2%

Source: ACEA (2024), *Economic and Market Report Global and EU auto industry: Full year 2023* [5.04.2024].

CO₂ emissions and life expectancy

Fossil fuels provide large amounts of stable and cheap energy, but their use has some drawbacks. The production of electricity in coal-fired power stations and to a lesser extent in gas-fired power stations is associated with high CO₂ emissions and environmental pollution.

Until 2000, the United States was the world's largest CO₂ emitter. In the following decade, China came out on top in terms of CO₂ emissions. In 2020, its share of CO₂ emissions was 28.1 per cent. CO₂ emissions in India and other developing countries have also gradually increased.

The share of Western countries and Japan in global CO₂ emissions is declining, but this applies to countries, not corporations. Many large companies have moved production, and thus emissions, to such countries as China, India, Indonesia, Malaysia, and Vietnam. For example, according to the Ministry of Commerce (MOFCOM), by the end of August 2023, a total of 1,150,000 foreign companies were registered in mainland China. In 2023 alone, 33,154 new foreign-invested enterprises were established in China⁵². Most foreign companies in China are engaged in manufacturing, with the top five industries being electronics, machinery, chemicals, textiles, and food processing.

TABLE 23. Total greenhouse gas emissions (kt of CO₂ equivalent)

COUNTRY	1990	2000	2010	2020
World (kt of CO ₂ equivalent)	30,629,971	34,208,319	43,442,887	46,120,921
World (%)	100.0%	100.0%	100.0%	100.0%
United States	19.1%	19.9%	14.9%	11.9%
China	10.6%	13.4%	23.5%	28.1%
Japan	3.9%	3.7%	2.8%	2.4%
Germany	3.7%	2.8%	2.0%	1.5%

⁵² <https://www.registrationchina.com/articles/how-many-foreign-companies-in-china/>

COUNTRY	1990	2000	2010	2020
India	4.0%	5.0%	5.9%	6.9%
United Kingdom	2.4%	2.0%	1.4%	0.9%
France	1.6%	1.5%	1.1%	0.8%
Russian Federation	9.7%	6.2%	5.2%	5.1%
Canada	1.8%	1.9%	1.6%	1.5%
Italy	1.6%	1.5%	1.1%	0.8%
E4	9.3%	7.8%	5.6%	3.9%

Source: World Bank (2024), <https://databank.worldbank.org/source/world-development-indicators/Series/EN.ATM.GHGT.KT.CE#> [17.04.2024].

The use of fossil fuels in the energy industry contributes to environmental pollution and can pose a health risk to residents. However, this negative impact is offset by various civilisational benefits. Development processes fuelled by cheap energy contribute to higher wages, improved quality, and increased life expectancy. In this respect, China has made the greatest progress in the last 31 years (an increase of more than 10 years). In 2021, during the COVID-19 pandemic, life expectancy in China (78.2) was clearly higher than in the USA (76.3).

TABLE 24. Life expectancy at birth, total (years)

COUNTRY	1990	2000	2010	2020	2021	CHANGE 1990–2021
World	65.2	67.7	70.7	72.2	71.3	+6.1
United States	75.2	76.6	78.5	77.0	76.3	+1.1
China	68.0	71.9	75.6	78.1	78.2	+10.2
Japan	78.8	81.1	82.8	84.6	84.4	+5.6

COUNTRY	1990	2000	2010	2020	2021	CHANGE 1990–2021
Germany	75.1	77.9	80.0	81.0	80.9	+5.8
India	58.7	62.7	66.9	70.2	67.2	+8.5
United Kingdom	75.9	77.7	80.4	80.4	80.7	+4.8
France	76.6	79.1	81.7	82.2	82.3	+5.7
Russian Federation	68.9	65.5	68.8	71.3	69.4	+0.5
Canada	77.4	79.2	81.3	81.7	82.6	+5.2
Italy	77.0	79.8	82.0	82.2	82.8	+5.8

Source: World Bank (2023), *Life expectancy at birth, total (years)*, <https://data.worldbank.org/indicator/SP.DYN.LE00.IN> [19.12.2023].

Conclusions

Energy from various sources, both non-renewable and renewable, is the fuel that drives human civilisation. Increasing energy consumption ensures continuous growth and development and contributes to the production of goods necessary for life and those that enhance its quality.

The hypotheses formulated in the introduction, suggesting that there is a growing role for countries in the global economy (measured by their share of global GDP and international trade) that increase their share of global primary energy consumption (H1), increase their share of global electricity production (H2), and provide market actors with relatively low (compared to other countries) energy prices (H3), have been confirmed.

Global influence is shifting towards those countries that are able to produce more energy at a relatively low price (China and India). In contrast, the importance of countries that have high energy prices and are not expanding their energy generation capacity at a sufficient pace (Germany, the United Kingdom, France, Italy, and Japan) is declining. The United States still holds a leading position in terms of GDP in exchange rate terms and the level of wealth of its citizens, but this position is gradually diminishing.

Increased consumption of primary energy may be associated with negative external factors but is most often a sign of increased production, increased population mobility, and improved quality of life.

In recent years, the Chinese economic model has become increasingly attractive to developing countries from South Asia, Africa, and Latin America. The model is associated with rapid economic growth, modern infrastructure, a wide range of attractively priced products and services, internal security, low energy prices, increasing life expectancy, and improving quality of life.

In future, it is likely that human labour will be increasingly replaced by robots, automata, and artificial intelligence, which means that such fundamental factors of production as energy and productive capital will play an even greater role as they will power the economy and determine its competitiveness.

The energy policy pursued in Europe to date has led to a decline in energy security – a far-reaching dependence on imports, limited diversification of energy supplies, high and rapidly fluctuating energy prices, and even energy shortages. There has also been a flight of energy-intensive industries to Asia. Products that are key for the economy, such as steel, aluminium, other metals, cement, lime, glass, ceramics, pulp, paper, cardboard, and chemicals, are largely produced outside the EU. Extending the ETS to further industries will further reduce the competitiveness of companies operating within the EU and, in combination with the Carbon Border Adjustment Mechanism (CBAM), lead to further price increases in EU economies. Unless Western European countries change their energy and industrial policies and attitudes towards underdeveloped and developing countries, they will be pushed out of fast-growing markets, such as Asia, Africa, and South America.

The analysis presented above has some limitations due to the scope adopted. In particular, it does not cover military, financial, and institutional issues. In military terms, the United States remains the greatest power, with second place still attributed to Russia despite its economic weaknesses. However, with economic growth, the military power of China and India grows. In terms of currency, it is the US dollar (USD) that continues to play a leading role, much more so than the US share of world trade would suggest. The global balance of power is also heavily influenced by large corporations and international institutions, such as World Bank, IMF, and WHO.

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The growth of the investment fund industry in the context of economic changes

Dariusz Filip

Introduction

According to Blake's approach¹, financial intermediaries belong, along with final market participants and market makers, to the main categories of financial system elements. Regardless of the financial market model operating in a given financial system, the most important financial intermediaries are banks, insurance institutions, and collective investment institutions, including investment funds.

Different types of collective investment institutions are the subjective scope of the study. According to SEC², mutual funds (or investment funds) are entities that pool money from many individual investors and invest in a diversified portfolio of securities, especially combination of stocks, bonds, money-market instruments, or other assets. Each unit share of the funds represents an investor's proportionate ownership of the funds' holdings and the income those holdings may generate. European regulations³, on the other hand, define investment

1 D. Blake, *Financial Market Analysis*, John Wiley & Sons, 2nd edition, London 2000.

2 SEC, *Mutual Funds: A Guide for Investors*. SEC Pub. 002 (08/07) 2008.

3 Directive 2009/65/EC of the European Parliament and of the Council of 13 July 2009 *on the coordination of laws, regulations, and administrative provisions relating to undertakings for collective investment*

funds by functioning undertakings for collective investment in transferable securities (UCITS) or alternative investment funds (AIFs). Both types of these institutions pool the savings of investors with similar investment goals. Each fund has its own individual investment objective, with corresponding risk levels and asset allocation. Their clients can buy or redeem shares in funds. UCITS as well as AIFs offer investors significant advantages in terms of risk diversification, risk-adjusted return, and investor protection. In order to better understand the functioning of these institutions, it should be mentioned that investment funds can be targeted at retail clients, institutional clients or both.

The rapid development of investment funds observed in the late 20th and early 21st centuries and their raised popularity among individual investors led to an increased interest in them directly as a subject of scientific inquiry. Numerous works on the relationship between the characteristics of funds and their performance in developed markets provide a reference for, *e.g.*, the analysis of emerging markets.

The purpose of this study is to determine the growth rate of the investment funds market in the context of economic changes. The thesis that will be put forward here is that the market for services provided by investment funds continues to grow rapidly in both product and value terms in all its segments, and that new financial instruments, in the form of further types of funds being created, are sustaining the scale of this growth. The relatively long research horizon taken into account, extending back as far as 20 years, will allow indirect inferences to be made with a broader background, referring to significant developments taking place in the global economy.

Now then, section 1 of this chapter includes a brief review of the financial literature related to the determinants of the investment funds industry, especially seminal works as well as contemporary studies covering the US mutual funds market and findings from non-US markets. Further on, section 2 presents a description of data. In turn, section 3 provides study's results, showing market trends and the directions of further development of the investment funds industry from a global perspective. Finally, section 4 concludes the main statements.

in transferable securities (UCITS) and Directive 2011/61/EU of the European Parliament and of the Council of 8 June 2011 on alternative investment fund managers (AIFMs).

5.1. A brief review of the literature on the subject

The dynamic development of the investment funds market, with favourable many periods of growth in the global stock markets observed, has led to increased interest in these financial institutions as a subject of scientific research. The main line of academic analysis and discussion⁴ related to the evaluation of the performance of investment funds dates back to the 1960s. However, one of the earliest works on the very functioning of investment funds was that by Carter, examining the quality of investment advice. He noted, for example, that larger funds were characterised by greater investment analysis capabilities, lower brokerage commissions, and greater market impact, which might have led to their superior performance as compared to their smaller competitors.⁵

The literature on the determinants of the investment funds industry development, like virtually all branches of research in the modern finance, is dominated by analyses of the US market. Today, the foreign literature on the subject consists of hundreds of papers dedicated to the evaluation of collective investment institutions conducted from different perspectives⁶.

One of the popular research analyses on the development of the investment funds market in the 1990s was the paper by Klapper *et al.*⁷ Using data on total net assets from 40 developed, developing, and transition countries, they studied the structure and growth factors of investment funds in different countries and tried to analyse the determinants of the investment funds growth. They noted that in developed countries, the development of the investment funds market was determined more by microeconomic factors, while in developing countries, it was macroeconomic issues. Equity funds, for example, predominate in developed

4 R. S. Carlson, *Aggregate Performance of Mutual Funds: 1948–1967*, "Journal of Financial and Quantitative Analysis" 1970, 5(1), pp. 1–32; I. Friend *et al.*, *Mutual Funds and Other Institutional Investors – A new perspective*, McGraw Hill Book Company, Nowy Jork 1970; M. Jensen, *The Performance of Mutual Funds in the Period 1945–1964*, "Journal of Finance" 1968, 23(1), pp. 389–416; W. F. Sharpe, *Mutual Funds Performance*, "Journal of Business" 1966, 39(1), pp. 119–138; J. L. Treynor, *How to Rate Management of Investment Funds*, "Harvard Business Review" 1965, 43(1), pp. 63–75.

5 W. D. Carter, *The quality of mutual fund portfolio supervision*, "Financial Analysts Journal" 1950, 6(4), pp. 32–36.

6 Cf.: G. Van Campenhout, *Mutual Fund Selection Criteria and Determinants of Individual Fund Flows*, "Review of Business and Economics" 2007, 42(4), pp. 617–671.

7 L. Klapper *et al.*, *The development of mutual funds around the world*, "Emerging Markets Review" 2004, 5(1), pp. 1–38.

countries, especially with the Anglo-American model of financial system, while bond funds were the best-formed segment of the market in most of Continental Europe and in middle-income countries. They linked it to high GDP *per capita* and low interest rates. The desirability of the funds market was determined by the low level of country risk and high investor confidence in the market⁸.

The operating conditions of the entities in question were analysed, among others, by Khorana and Servaes in the context of the future of this market worldwide. The authors noted that among the countries studied, there are still financial intermediation markets where the investment funds industry is still poorly developed, such as selected emerging markets countries. In other countries, where the markets are already quite mature, the list of funds offered is extensive, while they are mainly managed by just a few companies. Such markets, *e.g.*, North America and Western Europe, are characterised by relatively high levels of concentration. In the context of funds operating conditions, it was noted that there has been a favourable change in regulation, but quite a few aspects still need to be improved, especially outside the US, including in the area of service and transparency of the offering with a particular focus on costs and fees.⁹

Another similar work by Khorana *et al.* provides the results of the impact of the implementation of financial innovation on the size of a given market from the perspective of 56 countries. It is noted that the funds market is larger in countries where there are stronger rules, laws, and regulations for financial institutions and where investors' rights are better protected. Other factors considered to influence the size of the funds market included the level of wealth and citizens' education, age of the market, and the level of trading costs¹⁰.

Ferreira *et al.* studied the determinants of performance of open-ended actively managed investment funds from 27 countries. The analysis was based on pooled data from 1997–2007 on 16,316 equity funds. An extensive list of funds characteristics was studied, such as the fund size and the size of the company under which the fund operates, the fund age, costs and fees, and fund management structure. In turn, the characteristics defining the analysed countries include

8 Cf.: D. Fernando *et al.*, *The global growth of mutual funds*, "World Bank Policy Research Working Paper" 2003, p. 3055.

9 A. Khorana, H. Servaes, *On the Future of the Mutual Fund Industry around the World*. In: Fuchita, Y. and Litan R. E. eds., *Pooling money: the future of mutual funds*, Brooking Institution, 2008.

10 A. Khorana *et al.*, *Explaining the size of the mutual fund industry around the world*, "Journal of Financial Economics", 2005, 78, pp. 145–185.

the level of economic development, financial development, quality of legal institutions, structure of the investment funds market, and other factors. In the context of funds operating conditions, the findings of a positive relationship between funds' performance and the level of financial development are particularly interesting. Funds were found to perform better in countries with higher trading activity and lower trading costs. It was also observed that funds located in countries with a common law tradition perform better. In addition, investor protection and enforcement law have a positive and significant impact on performance¹¹.

Among more recent studies, the work of Dragotā *et al.* is definitely worth noting. In addition to the economic and financial factors traditionally cited in the literature behind the development of the investment funds industry, they turned to a set of socio-cultural measures that could explain the growth of this financial sector. They used data describing the investment funds market, but also non-market aspects, of 38 countries for the period between 1996 and 2009. The intention of the above-mentioned researchers was to answer questions on whether and how the size of the investment funds industry is affected by the degree of religiosity within a given country, the level of trust within a society, the level of happiness, and the percentage of the population believing that private ownership of business should be increased. They found a positive relationship between the perception of happiness and freedom of choice, which is a feature of countries dominated by the individualistic cultural codes, approaches, and values, as well as individuals' preference for private ownership and the development of investment funds. Furthermore, they proved that the industry is larger in developed countries with greater stock market liquidity, especially with low ratios of remittance inflows to GDP, and in which the industry is older.¹²

There are also a number of works¹³ devoted to analysing the market, in particular the existing trends in individual countries, usually in relation to experiences encountered on a geographically wider scale, such as the European market. For the Lithuanian market, for example, Simanauskas and Kucko looked for directions

11 M.A. Ferreira *et al.*, *The Determinants of Mutual Fund Performance: A Cross-Country Study*, "Review of Finance" 2013, 17(2), pp. 483–525.

12 I.-M. Dragotā *et al.*, *Determinants of Development of the Mutual Fund Industry. A Socio-Cultural Approach*, "Prague Economic Papers" 2016, 25(4), pp. 476–493.

13 Cf. L. Simanauskas, I. Kucko, *Trends of the Investment Fund Industry Development*, "Ekonomika" 2004, 66, pp. 110–131; D. Filip, *Market conditions of mutual funds functioning in Poland*, "Central European Review of Economics & Finance" 2017, 17(1), pp. 65–81.

for further development, drawing on the experience and history of the financial market in European countries. The motivation for starting this type of analysis was primarily the observed rapid development of this segment of the financial market and the increase in customer interest in it in one of the Baltic countries. In turn, Filip's study sought to reveal the structure of financial intermediary market, with particular reference made to investment funds, and to present the role they have played in the financial sector in Poland. In addition, an attempt was also made to determine the influence of market trends on the popularity of given segments of funds. The above analyses have shown that the development of collective investment institutions industry in these countries is incontestable.

5.2. Description of data

The data used in this study are a compilation of reports published by the European Fund and Asset Management Association (EFAMA). In contrast, their source was information made available by an organisation of national investment funds associations and the Investment Company Institute (ICI) on behalf of the International Investment Funds Association (IIFA). In order to conduct an in-depth analysis, it was necessary to adapt the collected data to the requirements of the author's study, showing market trends as well as the directions of further development of the investment funds industry from a global perspective.

Statistics from nearly 50 countries were included in this analysis. EFAMA, considering ICI's information, collected data from the following countries (in alphabetical order) from all continents: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Chinese Taipei, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, India, Ireland, Italy, Japan, Korea, Liechtenstein, Luxembourg, Malta, Mexico, Netherlands, New Zealand, Norway, Pakistan, Philippines, Poland, Portugal, Romania, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Trinidad and Tobago, Turkey, United Kingdom, and United States.

The total time horizon of this study reaches up to twenty years, however, different time perspectives have been used in different areas of the analysis. To be more specific, the basic timeframe is 2007–2023. Alternatively, to capture the most significant changes in recent years, the period from 2015 to 2023 was used. Table 1 shows an example of the number of investment funds in the market and the number of countries from where the data for the analysis was sourced, in selected years.

TABLE 1. Statistics of countries and investment funds included in the study

YEARS	2008	2009	2010	2011	2012	2013	2014	2015
Number of countries	43	44	45	46	45	45	46	45
Number of funds*	68 574	67 552	69 519	72 657	73 243	76 200	79 669	100 494
YEARS	2016	2017	2018	2019	2020	2021	2022	2023
Number of countries	47	47	47	47	46	46	46	46
Number of funds*	110 271	113 847	118 978	122 528	126 457	131 808	137 892	139 982

Note: *Data excluding funds of funds.

Source: Own compilation based on data from the European Fund and Asset Management Association (EFAMA) reports.

The statistics included in this study were collected from 43–47 countries, depending on the year of analysis. It should be noted that the summary presented in Table 1 does not include funds of funds. The number of funds increased from 68 574 in 2008 to 139 982 in 2023, which is more than doubled. The average annual growth rate in the number of funds was 4.9 per cent. However, it should be noted that EFAMA, in publishing its data since 2015, has expanded the scope of the data presented, including guaranteed/protected funds and real estate funds. In addition, reaching out to ETFs and Institutional Funds led to an increase in the number of funds, and total net assets in individual tables as well.

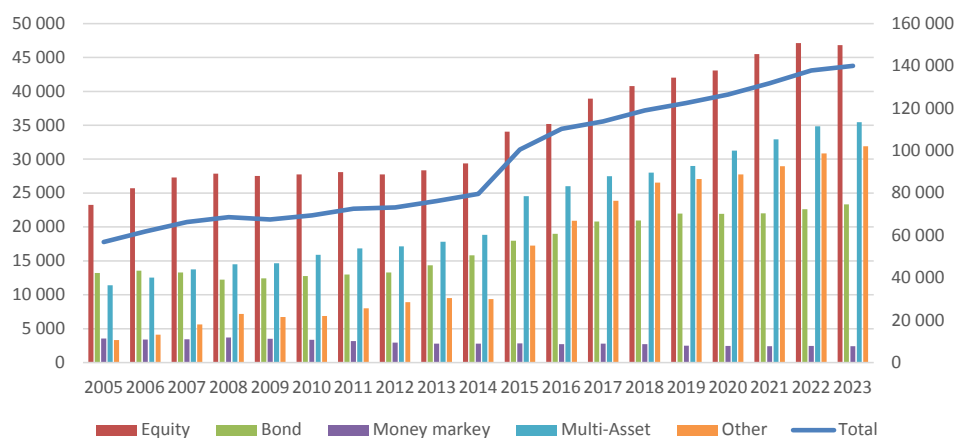
5.3. Conceptual issues and results

As mentioned in the introduction, the purpose of this paper is to show in global terms the pace of development of the investment funds market, along with emerging trends, but also to indicate the future directions of change facing this segment of financial market institutions. This will be possible due to the application of several areas of analysis, which will allow us to assess the development of the market

from two perspectives: quantitative and value. The first approach proposes that the development of the industry will be documented by the width of the market, that is, the number of entities operating in the market. The latter perspective will additionally be considered in two dimensions – the value of the market and the popularity of its various segments in particular periods of development, but also geographically, *i.e.*, in a comparative analysis referring to the most important countries. The size of the market as well as its segments can be measured by the value of the assets of the entire sector and its components.

Figure 1 provides information on the number of investment funds recorded by EFAMA, considering ICI's information, collected data from countries from all continents. The compilation excludes funds of funds. The components may not sum to total because of unclassified funds. The number of funds is determined at the end of each year.

FIGURE 1. Number of funds of global investment fund industry



Source: Own compilation based on data from the European Fund and Asset Management Association (EFAMA) reports.

The data in Figure 1, by fund type, refer to the left scale. In turn, the total number of entities reported is presented in a line graph with the figures set aside on the right-hand scale. As mentioned in Section 2, in 2015 the data provider expanded the criteria for classifying funds. This led to a significant increase

in both the reported total number of funds and their individual types. This also means that the market's growth rate in this particular period should be viewed as a change in the reporting approach rather than an actual acceleration of growth in terms of the number of entities.

The total doubling of market participants mentioned in Table 1 was uneven. During pre-crisis periods, *i.e.*, between 2006 and 2007, or better global market conditions, *e.g.*, 2016, 2018, and 2022, a 5–10 per cent increase in the total number of funds could be observed.

The most numerous groups of funds over the entire nearly 20-year period of analysis were equity funds. Their number increased from 23,264 in 2005 to 46,828 in 2023. The periods of greater popularity for this type of collective investment product coincide with the interest of individual investors throughout the global investment funds market. The chart in question does not include this information, but the quantitative share of this group of funds in the total number of funds ranged between 32 and 42 per cent.

Other funds groups that account for a significant quantitative share of all fund types are multi-asset funds (the share of this group of funds in the total number of funds amounts to 20–25 per cent) and bond funds (17–23 per cent). The former, which include balanced or stable growth funds, experienced a tripling in terms of the number of entities, *i.e.*, from 11,392 in 2005 to 35,471 in 2023. In contrast, the number of bond funds increased from 13,232 in the first year of the analysis to 23,338 last year.

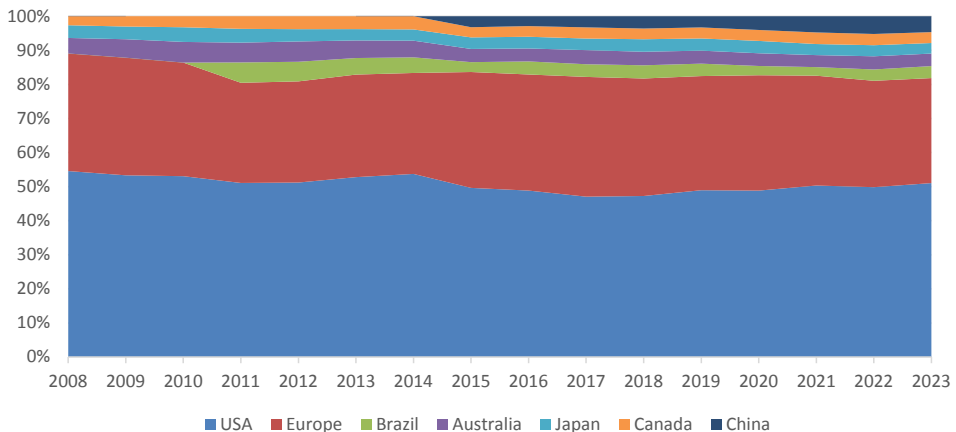
The most dynamic growth in terms of the number of market participants was registered for other funds, *i.e.*, from 3,317 in 2005 to 31,911 in 2023, more than nine times. However, this is due to the increased market demand for products such as real estate funds. At the opposite pole are money market funds. Their number over nearly 20 years has fallen from 3,535 in 2005 to 2,434 in 2023, a drop of one-third. Nevertheless, one should not draw too far-reaching conclusions on this basis since for some types of funds, there may be a phenomenon of mergers or a tendency for only the larger entities that take over the assets of those being liquidated to remain in the market. Assessing the market based on the number of entities is the first step in studying the development of the entire industry.

The next step of the analysis will measure the size of the market and assess the development of the market in terms of products. This will be done by compiling the net asset value in two perspectives – in a geographical perspective, in which the scale of investment funds activity in individual countries

and thus its importance for the overall funds industry worldwide will be established; and in the product perspective, where an assessment will be made of the allocation of client assets to the various segments of the global investment funds market.

Total net assets will be used to measure the aforementioned market size and its evolution over the horizon of the last 16 years. Figure 2 shows geographical trends in the investment funds assets in percentage, where 100 per cent is the total net assets of the investment funds industry, including funds of funds.

FIGURE 2. Market share of the most relevant countries in the total global investment funds industry



Source: Own compilation based on data from the European Fund and Asset Management Association (EFAMA) reports.

Figure 2 presents the percentage ratio of the value of investment funds assets of the largest and geographically most important markets to the total market value. The market value of the 7 countries included represents approximately 98 per cent of the value of the total global investment funds industry, taking into account all types of funds. Due to differences in the coverage of the data in EFAMA's reports, parts of the data for a few selected countries have been included in subsequent years of analysis. Nevertheless, this does not distort the overall picture of the market, showing the increasing importance of individual geographical regions.

According to the data collected, approximately half of the asset value of the entire investment funds industry is held in the US investment funds. This has remained constant throughout the analysis period. The market for European investment funds is the second key geographic area for this type of entities, after the US. The share of European funds in the total market oscillated between 30 and 35 per cent. Other countries in the list presented in Figure 2 maintain their current market shares, *i.e.*, Brazil 4 per cent, Australia 4 per cent, Japan 3 per cent, or even Canada 3 per cent. Only Chinese investment funds are operating steadily, however, increasing their share of the overall market from 3 per cent to 5 per cent. At the moment, it is difficult to indicate any reshuffling of market shares in this market in the near future. Nonetheless, we must remember that the globalisation of the economy also has a significant impact on the financial market. Intense trade between countries means that economic events in one region can have immediate consequences for markets around the world. For example, trade conflicts between the US and China can lead to falling share prices on global stock exchanges and thus to changes in the value of assets held by collective investment institutions.

Taking a closer look at the value of investment funds assets in each global market and how they have changed over time will allow the pace of development of the overall market to be determined and geographical trends to be captured. Table 2 summarises the net asset values of investment funds registered in each global region.

As mentioned earlier, the world's leading investment funds market is the United States. Over the last 16 years, the value of assets in this market has increased almost fourfold, *i.e.*, from EUR 7,236 billion to EUR 33,230 billion, which also gives an average annual growth rate of 10.7 per cent. The highest growth rate in the value of assets of US funds was observed in the post-crisis periods, *i.e.*, from 2009 to 2010, but also in periods of better stock market conditions (*e.g.*, between 2014 and 2015, in 2019, and in 2021), as almost half of the value of assets of the US investment funds is located in equity funds and this has been maintained for at least half of the analysis period. Other significant types of investment funds (bond, money market, multi-asset) in the US market account for between 12 and 17 per cent of the total market. The rate of the value change in these market segments was similar to the equity funds discussed earlier. Most noteworthy are the multi-asset funds whose increase in value particularly in the first half of the study horizon was very impressive.

Europe, the second most relevant market for investment funds globally, is very diverse, but a detailed discussion of this can be the subject of a separate study. It

should be reiterated that for some of the data in 2015, the data provider expanded the criteria for classifying funds, hence the increase in the value of assets during this time, particularly for European investment funds, can be quite problematic from an explanatory perspective. The total value of this market has increased over the entire study period from EUR 4,575 billion of assets to EUR 20,060 billion of assets, which also gives an average annual growth rate of around 10 per cent. As was the case for investment funds in the US market, the European assets of collective investment vehicles grew dynamically during the corresponding periods, *i.e.*, in a manner correlated with periods of better prosperity on global stock exchanges. Nevertheless, in three periods, *i.e.*, in 2011, 2018, and 2022, a reduction in the value of assets placed in the portfolios of these financial intermediaries was observed. The segmental structure of the European market differs slightly from that known from the US market. The largest amount of assets, one third of the market value, is still placed in equity funds, but bond, multi-asset, and other funds each hold around 20 per cent of the money. Only less than 10 per cent of total European market assets are directed towards money market funds.

The two other geographical areas that can be identified through the Anglo-Saxon model of the financial system, Australia and Canada, can be discussed together due to the similar size of these markets. The only difference relates to the reporting of part of the data as in several periods, the national investment funds associations of Australia has not recorded part of the data and does not classify multi-asset funds. Total assets for the aforementioned Australian investment funds market increased from EUR 604 billion in 2008 to EUR 2,394 billion in 2023, which also represents a nearly 3-fold increase. This translates into a nearly 10 per cent average annual rate of change, but hugely dynamic increases were felt in the early years of the analysis. Currently, the market is growing steadily; there are periods of declining asset values (*e.g.*, in 2013, 2018, and 2022). With regard to the Canadian market, an even more dynamic increase in net assets should be noted. The increase in the value of the market in question from EUR 350 billion in 2008 to EUR 2,083 billion in 2023 means that in Canada, the value of investment funds allocations increased by as much as five times, which translates into an average annual growth rate of nearly 13 per cent. Particularly significant (above 20 per cent) increases in net asset value were observed at the beginning of the study period, but also during periods when stock markets were better. This is related to the fact that nearly one-third of Canadian investment funds assets are placed in equity funds and up to half in multi-asset funds.

TABLE 2. Regional summary of net asset value by type of funds (in billions of EUR)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
USA	7 236	8 188	9 541	9 792	10 859	12 045	14 472	17 887	19 674	20 315	20 246	25 130	26 261	33 018	29 339	33 230
equity	2 662	3 441	4 241	4 023	4 498	5 631	6 848	9 178	10 205	11 053	10 553	13 438	14 101	18 503	15 717	18 254
bond	1 125	1 531	1 952	2 231	2 597	2 392	2 851	3 447	3 867	3 853	4 100	4 912	5 107	6 050	5 395	5 647
money market	2 754	2 302	2 098	2 080	2 041	1 971	2 245	2 530	2 588	2 374	2 652	3 233	3 531	4 199	4 478	5 357
multi-asset	358	445	555	648	751	895	1 113	2 686	2 954	2 978	2 883	3 471	3 400	4 144	3 620	3 850
Europe	4 575	5 299	5 993	5 634	6 295	6 866	7 979	12 253	13 721	15 168	14 772	17 198	18 201	21 145	18 374	20 060
equity	1 173	1 575	1 920	1 853	2 099	2 531	2 891	3 392	3 768	4 429	4 111	5 130	5 584	7 171	5 806	6 524
bond	915	1 064	1 256	1 512	1 850	1 942	2 298	2 788	3 271	3 556	3 451	4 121	4 217	4 421	3 718	4 077
money market	1 027	977	824	1 054	1 015	912	952	1 197	1 266	1 272	1 265	1 326	1 503	1 545	1 586	1 758
multi-asset	638	763	898	904	995	1 113	1 378	2 681	2 826	3 188	3 117	3 701	3 816	4 395	3 762	3 927
Brazil	n.a.	n.a.	n.a.	1 145	1 220	1 108	1 233	1 043	1 544	1 604	1 659	1 870	1 461	1 649	1 956	2 290
equity	n.a.	n.a.	n.a.	69	79	67	57	43	58	76	96	168	153	151	141	169
bond	n.a.	n.a.	n.a.	435	455	407	469	669	1 009	1 010	998	1 009	695	771	978	1 156
money market	n.a.	n.a.	n.a.	31	34	34	37	47	68	66	67	75	75	78	91	113
multi-asset	n.a.	n.a.	n.a.	168	177	156	163	219	309	356	394	479	420	479	534	572
Australia*	604	832	1 090	1 113	1 264	1 178	1 319	1 397	1 530	1 788	1 700	1 959	2 007	2 312	2 277	2 394
equity	n.a.	n.a.	n.a.	442	501	472	531	553	577	819	745	862	875	1 017	982	1 005

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
bond	n.a.	n.a.	n.a.	57	65	58	70	76	89	56	60	77	76	76	83	99
money market	n.a.	n.a.	n.a.	219	261	246	n.a.	n.a.	n.a.	n.a.	n.a.	216	224	214	239	243
Japan*	495	572	774	776	764	758	889	1220	1385	1467	1575	1837	1950	2132	1912	2 014
equity	324	375	484	470	462	448	530	1 078	1 241	1 323	1 439	1 678	1 780	1 961	1 762	1 869
bond	69	65	83	86	81	100	99	130	143	37	35	39	43	43	29	25
money market	21	18	21	20	16	13	14	13	1	96	87	103	108	107	100	97
Canada	350	464	581	709	805	862	1 042	1 077	1 259	1 417	1 346	1 662	1 726	2 233	1 943	2 083
equity	113	154	179	199	204	227	265	270	314	396	371	468	499	704	621	695
bond	32	47	64	84	100	91	102	105	127	161	154	208	226	265	233	259
money market	42	36	28	26	23	19	18	17	17	17	19	24	27	23	35	52
multi-asset	109	152	202	256	297	328	408	669	792	830	788	940	947	1 215	1 030	1 047
China	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1 160	1 165	1 408	1 545	1 684	2 166	3 117	3 062	3 032
equity	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	108	96	97	105	166	257	359	337	361
bond	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	99	195	188	288	354	341	569	581	677
money market	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	629	585	863	970	910	1 008	1 315	1 421	1 437
multi-asset	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	315	274	248	173	242	544	841	679	504

Source: Own compilation based on data from the European Fund and Asset Management Association (EFAMA) reports.

Note: Components may not sum to total because of rounding or unclassified funds. *** means that multi-asset funds were not reported in the countries concerned.

Another of the geographical areas worth looking at is Brazil. Since 2011, the investment funds market there has been the subject of detailed records maintained by the data provider. The trend in this region is slightly different from what has been seen previously. The net assets held by investment funds from the South American country grew from EUR 1,145 billion to EUR 2,290 billion over 13 years. This means that the average annual growth rate was just under 6 per cent, which seems quite moderate. The market was particularly affected by periods when the net asset value fell by 15 per cent or even 22 per cent in 2015 and 2020, respectively. While in the first case the change in asset value may be dictated by differences in the funds' classification adopted by the data provider, in 2020 the market saw a bump in the bond funds segment. This is linked to the fact that bond funds are the dominant fund type operating in the Brazilian market, with more than 50 per cent of the asset value of all investment portfolios. In comparison, the equity funds market accounts for a small portion of Brazilian investment funds assets, only 7 per cent.

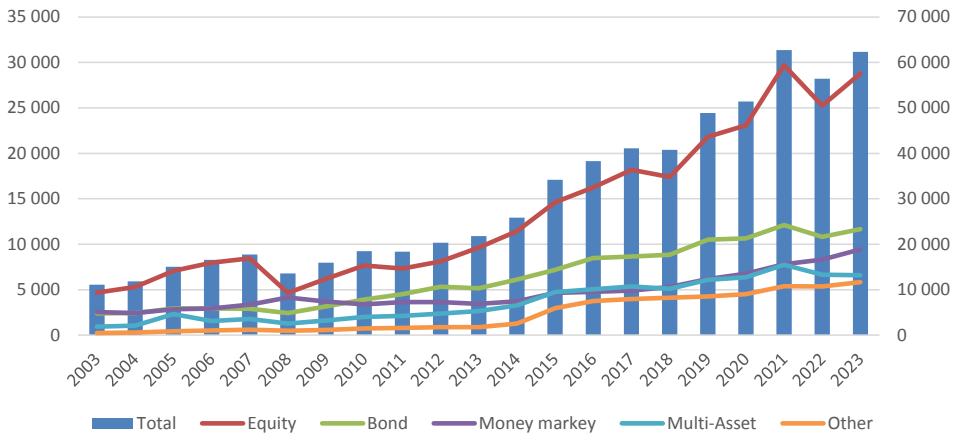
Japan and China, the last two geographically similar investment funds markets, will be discussed together due to area proximity, although the differences as well as the trends there are quite significant. In the case of Japan, as a developed country, the development of the investment funds market in terms of asset value is remarkable. A 5-fold increase in net assets from EUR 495 billion in 2008 to EUR 2,014 billion in 2023 translates into a nearly 10 per cent average annual growth rate. It is important to emphasise at this point that the Japanese investment funds market is mainly an equity-based market (nearly 93 per cent of the value of the total market). Changes in the stock market translate into the valuation of equity funds' portfolios and therefore the valuation of the entire domestic funds market. This can be seen in periods of both ups and downs in asset values. In comparison, the investment funds market in China, previously identified as the fastest growing one, has a completely different structure. Data published by EFAMA, in this case, are available from 2015 onwards, but nevertheless, over a period of just nine years, net asset value growth was characterised by the highest average annual rate of 13 per cent. The asset value for the entire market in China increased from EUR 1,160 billion in 2015 to EUR 3,032 billion in 2023. However, it should be noted that the net asset value has been declining for the last two years. The aforementioned different market structure in the case of Chinese investment funds means that the dominant type is money market funds, which account for nearly 50 per cent of total assets. Bond funds are also a fairly significant segment in China (22 per cent),

which means that we should look for very different trends here than in geographically different investment funds markets.

However, it is important to remember that among the key factors influencing the financial market are changes in fiscal and monetary policy. Decisions taken by governments and central banks, such as interest rate changes, quantitative easing programmes, or tax reforms, can result in changes in the prices of shares, bonds, and currencies and therefore affect the attractiveness and popularity of particular types of investment funds.

The last stage of the analysis is the compilation of net asset values in individual fund types. The allocation of amounts to individual market segments, together with the determination of value changes in subsequent years of the study, will help to clarify market trends in terms of clients' preferences as to the type and characteristics of instruments in their investment portfolio. Figure 3 summarises the net asset values of investment funds allocated to each fund type.

FIGURE 3. Net asset value by investment funds market segment (in billions of EUR)



Source: Own compilation based on data from the European Fund and Asset Management Association (EFAMA) reports.

Note: Components may not sum to total because of rounding, unclassified funds or missing components.

Figure 3 provides another, but slightly different, look at the global investment funds industry – this time from the perspective of the importance of individual

fund types. On the other hand, however, it is a continuation of the previously noted conclusions from the market entity analysis (Figure 1). In the overview presented here, funds of funds are excluded, while the values of assets held in ETFs and Institutional Funds are included in Totals.

The data in Figure 3, by fund type (line chart), refer to the left-hand scale. In contrast, the total net asset value of investment funds (column chart) is set aside on the right-hand scale. As already mentioned, in 2015 the data provider expanded the criteria for classifying funds, which also led to an increase in the value of assets among all types of funds, which should be considered through a change in data coverage and not an actual extraordinary increase in market value.

The description of the data collected should begin with an assessment of the growth rate of the market, which is in principle also presented in Table 2. However, in this case the study horizon has been significantly extended to 21 years. The value of the entire market has increased from EUR 11,123 billion in 2003 to EUR 62,309 billion in 2023, giving an average annual growth rate of 9 per cent. However, it should be noted that during periods of rapid change, triggered by various global crises, *e.g.*, the financial crisis in 2008, the emerging market crises in 2018, or the consequences of Russia's aggression in Ukraine in 2022, the value of global investment funds assets declined slightly by, respectively, 23 per cent, 1 per cent, and 10 per cent.

The value of the assets of the main types of funds investing entirely or partially in equities, such as equity and multi-asset, have increased by 5–6 times over the period mentioned. For these types of funds, equity market turbulence had a dramatic impact on the portfolio valuations and the scale of capital outflows. Slightly calmer reactions to market turbulence were observed in the case of safer types of funds – bond and money market, which increased respectively 4 and 3 times. On the other hand, the largest increase in the popularity of this type of collective investment institutions, expressed in terms of net assets, was recorded in other funds (“Other”). The increase in assets from EUR 246 billion in 2003 to EUR 5,824 billion in 2023 marks a spectacular change, behind which is a huge fashion, especially in recent years, for passive investment in ETFs or even Institutional Funds.

Conclusions

As mentioned, the dynamic development of investment funds, observed in the late 20th and early 21st centuries, and their raised popularity among individual investors led to an increased interest in them directly as a subject of scientific inquiry. The vast majority of works on the performance of investment funds have pointed out that it is difficult for them to achieve returns above the benchmark, and yet the market continues to grow. Also, the regular occurrence of multiple crises and financial market turbulence in recent decades has not led to a halt in the growth of client interest in these financial institutions¹⁴.

As the study shows, the growth of the investment funds market continues to be quite high and stable, both in product and value terms. This has been observed practically in all market segments, *i.e.*, with regard to the various types of funds and the main geographical trends. It is understandable that certain types of funds have gained ground at certain times and others have lost ground, but this has mainly been due to the existing conjuncture in the financial markets at the time. The high growth rate of mutual funds is due to the introduction of new product solutions (*e.g.*, exchange-traded funds) into the fund range, despite changing investor preferences or the new trend to invest independently in cryptocurrencies or even commodities and raw materials or through ETC instruments (*e.g.*, exchange-traded commodities)¹⁵. In addition, demographic changes, such as an ageing population and changes in social structure, may affect investment preferences and demand for various financial products, such as bank loans, investment funds, pension funds, or insurance¹⁶.

Economic changes are having a significant impact on the financial market, introducing both challenges and new opportunities for investors and financial institutions. Technological innovation is an undeniable factor influencing

14 Cf.: P. Komorowski, *Financial security of a small open economy in conditions of globalization as a requirement for economic growth*, "Journal of Management and Financial Sciences" 2019, 12(37), pp. 9–24; D. Prokopowicz, P. Komorowski, *Impact of the Coronavirus Pandemic (COVID-19) on Financial Markets and the Economy*, "International Journal of Legal Studies" 2021, 2(10), pp. 85–116; A. T. Tudorache, L. Nicolescu, *Macro-economic evolutions during the COVID-19 health crisis – large versus small European countries*, "Proceedings of the International Conference on Business Excellence" 2022, 16(1), pp. 1073–1086.

15 T. Miziołek, *Inwestowanie indeksowe. Instrumenty finansowe typu ETN i ETC*. Wydawnictwo Maklerska.pl, Poznań 2023.

16 Cf.: F. Allen, K. Jackowicz, O. Kowalewski, Ł. Kozłowski, *Bank lending, crises, and changing ownership structure in Central and Eastern European countries*, "Journal of Corporate Finance" 2017, 42, 494–515.

the financial market. Developments in information technology, such as trading algorithms, blockchain, or artificial intelligence (AI), are changing the way investors make investment decisions and what financial products are available on the market.

It should be noted that, for several years now, institutional investors' asset allocation decisions on the capital market have increasingly been made using AI¹⁷. This includes neuro-linguistic programming (NLP), machine learning, or even big data technologies, which are used to improve the efficiency of investment algorithms¹⁸. According to the CFA Institute's report, although the solutions provided by artificial intelligence are still treated as mechanisms supporting the decision-making process, they are used to build trading signals, establish correlations between individual assets or analyse the sentiment of investors active in social media, and track consumer trends in particular age groups¹⁹. Nevertheless, investors and financial institutions need to be aware of economic changes and their impact on the financial market in order to make informed and considered investment decisions and adapt their strategies to the changing economic environment.

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The green economy and the circular economy as models for addressing environmental change

Bartosz Stachowiak

Introduction

Climate change and its impact on society and the economy are being felt by people and biota. In present and future terms, particularly from the point of view of society and functioning economic systems, climate change is already happening. What causes climate change and whether it is part of a larger cycle of change should not be a primary focus of discussion in social science.

Studies of the climate change cycle and, in particular, of changes in the Earth's temperatures do not clearly show the causes of climate change. According to one group of researchers, *global climate change is nothing new. For example, the last 500 millennia have seen regular cycles of the Earth's climate, alternating between ice ages and interglacial periods (...). The global average surface temperature, after rising by about 0.6 °C during the 20th century, is projected to rise from 1.4 to 5.8 °C this century, at a rate that is very likely [90 per cent] to be on an unprecedented scale in at least the last 10,000 years. The threat of an impending ice age has given way to "opposite" fears of much more immediate climate change. The reason for this is that over the past century, humanity has inadvertently become a powerful force in terms of its impact on the Earth's climate system and has turned from a climate receiver to a climate*

creator.¹ Another group of researchers points to natural solar cycles and presents scientific studies to support this².

Irrespective of the ongoing discussion about the causes of climate change, the effects of climate change are beginning to be felt more and more. This, in turn, is starting a discussion on whether to reduce anthropogenic factors or adapt to the coming climate change. Humanity has been experiencing gradual natural and environmental change over the past few decades.

This change is the impetus that initiates the modification of social and economic processes or the creation of the new ones, which may lead to new polycrises or make the existing crises escalate. To address this, new solutions have been sought, based on an interdisciplinary approach, inclusive of natural, social, and technical sciences in the theoretical and practical dimensions of the functioning of economic systems.

1 Müller B., The Global Climate Change Regime: Taking Stock and Looking Ahead, www.wolfson.ox.ac.uk/~muller, February 2002, p. 2.

2 In the book by Singer SF, Avery DT (2008) UNSTOPPABLE GLOBAL WARMING-Every 1,500 years, Rowland & Littlefield Publishers, Maryland, USA, *the authors discuss seven diverse scientific studies ranging from ice cores to fossilised pollen [4] that all demonstrate effective thermal cycles from hot to cold every nominal 1,500 years (1,500 years ± 500 years). The SCM also models the Earth's past, historically documented temperature epochs. The SCM is an alternative to the United Nations Intergovernmental Panel on Climate Change (UNIPCC) AR5 [5] and AR6 [6] models which consider human-caused greenhouse gas accumulation into the upper atmosphere as the primary cause of this warming. The UNIPCC models do not accurately model the measured Earth temperatures and more recent models may be even less trustworthy [7]. Both the SCM and UNIPCC models predict that Earth temperatures currently will continue increasing. The SCM predicts that Earth temperatures will increase a total of 1.75 °C from 1850 until the year 2232 when maximum temperature will be 15.39 °C which afterward will decline toward the next little ice age. The UNIPCC model predicts increasing temperatures until the greenhouse gases stabilise with added gases exactly balancing removed gases (net zero). Earth temperature would then remain at the last level unless total greenhouse gases decrease or other changes are made to reduce net solar irradiation arriving at the Earth's surface. The SCM uses measured Earth temperatures from 1850 to 2020 as its input data and therefore any greenhouse gas effects over that time span are already present within the model. The SCM found that measured Earth temperatures themselves exhibit a 73-year secondary solar cycle in addition to a primary 1,071-year solar cycle that fits the timing of prior historical temperature epochs like the Little Ice Age and Medieval Warming. A third solar cycle of 11 years was incorporated to clarify understanding of several Earth Science correlations as they relate to the SCM. After the SCM was completed, it was found to agree quite closely with Earth Science correlations including Sunspots, the Atlantic Multidecadal Oscillation, the Power Dissipation Index, the Accumulated Cyclone Energy Index, the Pacific Decadal Oscillation, and the El Niño Southern Oscillation. The trends in these data sets are mirrored very closely by the SCM. The SCM predicts that La Niña in the Southern Pacific Ocean will dominate 60% of the time during the next two decades and Atlantic hurricanes will be less energetic while all other correlations studied will decline for the next two decades. Currently increasing temperatures on Earth are part of its natural temperature cycle that has been occurring for as long as the last 15,000 years.* Source: De Nierode, Solar cycles control Earth Temperatures Past, Present and Future, Environmental Analysis & Ecology Studies, March 12, 2024, p. 1.

This has resulted in the concepts of green economy³ and circular economy⁴. Each of these concepts directly addresses sustainability issues and implies the creation of new economic policies, research and development activities, and a shift in the approach of basic economic actors to climate change and how it can be tackled. The green economy and circular economy paradigm take a holistic approach to many issues. In other words, in an era of globalisation, these two concepts emphasise a global approach. This is why many postulates underlying these concepts require the cooperation of countries and enterprises as well as public support. Unfortunately, this is not easy to implement, often due to the particularistic interests of a given country, social group, or industry, leading to disruptions that can have a major impact on the prevention of climate change and its consequences, such as droughts, fires, sudden rainfall, flash floods, changes in temperature affecting crop patterns, etc.

Climate change is also a driving force for particular measures, including the decarbonisation of economies, and thus initiates energy transition processes and launches a circular economy. As a result, it triggers two separate areas: (1) the search for technologies and energy carriers that will preserve or improve the competitiveness of enterprises and (2) the development of the relevant, new and innovative, technologies and their implementation on the market. Consequently, new national specialities are developing, and the position of world economies is changing. Therefore, it is necessary to determine current constraints faced by the countries and identify solutions.

The aim of this paper is to present the significance of the climate change risks for the functioning of society and the economy. The significance of climate change risks has triggered a search for ways to counteract climate change (assuming that it is due to anthropogenic factors). This search led to the emergence and development of the concept of green economy and circular economy. The practical dimension of introducing green economy and circular economy has been analysed based on selected areas of the economy of the EU, China, and the USA. These are currently

3 The term first appears in the 1989 report „Blueprint for a Green Economy“ by David Pearce, Anil Marandya and Edward B. Barbier, published in 1989.

4 In a 1976 research report for the European Commission in Brussels, titled *“The Potential for Substituting Manpower for Energy,”* its authors, Walter Stahel and Genevieve Reday, outlined a vision of a looped economy (or circular economy) and its impact on job creation, economic competitiveness, resource conservation, and waste prevention. The report was published in 1982 as the book *“Jobs for Tomorrow, the Potential for Substituting Manpower for Energy.”* Today, these factors are commonly referred to as the three pillars of sustainability: environmental, economic, and social. Source: product-life.org.

the main players involved in the development of clean technologies, technological development, and the search for and implementation of product and process innovations that can be applied in energy transition processes. It is worth highlighting the different ways in which similar economic, environmental, and technological objectives can be pursued to reduce greenhouse gas emissions and adapt to the environmental changes that may be coming as a result of climate change.

6.1. Climate change: social and economic consequences

Climate is the variable that influences all processes in biocoenoses and populations and thus affects habitats and abundance of organisms. It is just one piece of the puzzle that makes up the whole picture, alongside many other changes. Climate change is perverse in nature; it can simultaneously cause droughts on one continent and excessive rainfall on another. *Over the last 100 years, global temperature has continued to rise intermittently. During this period, the Earth's average temperature has risen by 10 °C. The last 1000 years in the Northern Hemisphere have been cooler than the 1961–1999 average (...). If we look at different parts of the world in more detail, we can see that climate change has not been evenly distributed over the Earth's surface. The largest increases in temperature were found in the north-west of North America. Significant changes were also found in parts of Eurasia, Africa, western Canada, and Greenland. Most of the oceans along South America and Australia have warmed slightly (0.2 °C to 10 °C). On average, the temperature increase over the last 50 years has been twice that of the last 100 years. It is beyond doubt that the Earth is getting warmer.*⁵

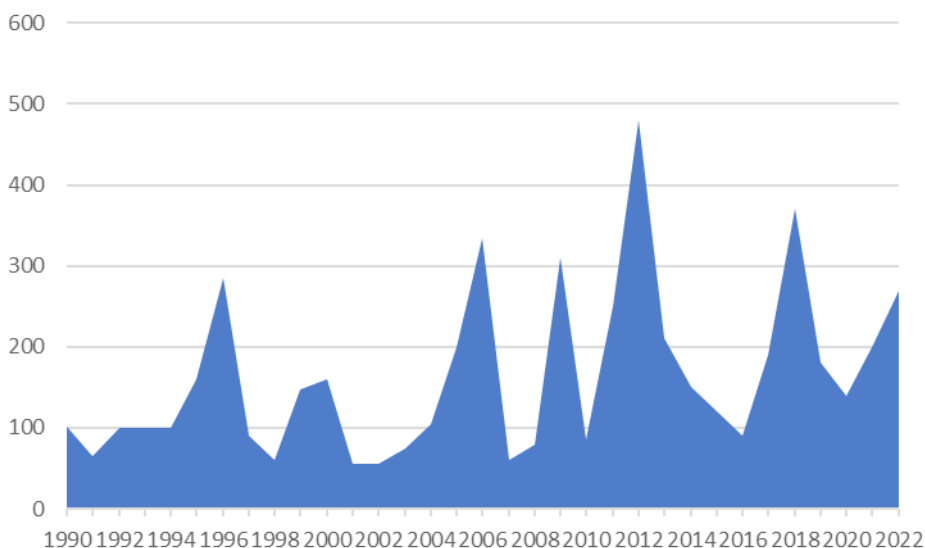
The change is induced by the planet-warming effect, called the greenhouse effect, that causes the surface of the planet to warm as a result of the emission of infrared radiation that occurs in the Earth's atmosphere. The processes resulting in global warming are influenced by greenhouse gases. Greenhouse gases are gases present in the Earth's atmosphere that reemit infrared radiation (long-wave radiation) to the Earth's surface, contributing to an increase in temperature. The most important greenhouse gases include carbon dioxide, methane, CFCs, nitrogen dioxide, and water vapour. Most greenhouse gases come from natural sources (such as water vapour, which is responsible for 36–70 per cent of the greenhouse

5 Krebs, Ch. J.; *Ekologia – eksperymentalna analiza rozmieszczenia i liczebności*, PWN, Warszawa, 2011, p. 527.

effect, excluding clouds), but the increase in emissions of some greenhouse gases is the result of various human economic activities. The warming causes irregular changes in precipitation in different parts of the globe. This results in short-term physical phenomena, such as El Niño–Southern Oscillation and the melting of snow and ice, which is a sign of global warming.

Over the past five decades, there has been a significant increase worldwide in the number of events that are classified as extreme. *From 1981 to 1990, there was an average of 79 natural disasters per year compared to as many as 186 in the last decade. The financial losses associated with the effects of extreme events have also increased significantly. The annual average between 1981 and 1990 was almost USD 41 billion in losses. In the last decade (2012–2021), it is almost 5 times as much – more than USD 193 billion (Figure 1).*⁶

FIGURE 1. Losses from natural disasters in 1990–2022 (in USD billion)



Source: Internal analysis derived from: *Klimat rosnących strat. Rola ubezpieczeń w ochronie klimatu i w transformacji energetycznej – rok 2023* [A climate of increasing losses. The role of insurance in climate protection and the energy transition – year 2023], Polska Izba Ubezpieczeń, EY, Warszawa, 2023, p. 9.

⁶ *Klimat rosnących strat. Rola ubezpieczeń w ochronie klimatu i w transformacji energetycznej – rok 2023* [A climate of increasing losses. The role of insurance in climate protection and the energy transition – year 2023], Polska Izba Ubezpieczeń, EY, Warszawa, 2023, p. 9.

From 2019 to 2021, various types of natural disasters were the cause of damage with a total amount of more than USD 600 billion. In the United States, Hurricane Ida contributed to the largest losses, estimated at USD 65 billion. Another example is the Bernd flood in Europe, which caused damage estimated at USD 54 billion.

The social dimension of natural disasters can be presented by the number of people affected. The 2022 floods affected nearly 33 million people. Nearly 1,700 people died, and 7.9 million people were displaced. Due to the floods, around 600,000 people are living in temporary camps. The floods in Nigeria that occurred in October 2022 caused the deaths of more than 600 people and forced the displacement of around 1.3 million people.

Changes in temperature (from extremely low to high) lead to changes in the energy system and can therefore affect the energy security and economic security of a country and contribute to a loss of competitiveness for economic players operating in a particular region of the country and, in extreme cases, national economies. An example of this is severe cold weather that took place in Texas (USA) in February 2021. *Essentially everything about Texas's energy system over the past several days failed miserably. About half the state's wind turbines froze and shut down – though ones that were winterized have kept going in other states and in regions such as Siberia. But fossil fuel plants, natural gas-fired ones in particular, were a bigger problem, because of a failure to insulate pipes and to otherwise winterise equipment. As of Wednesday morning, when the power outages were at their most severe, the cold had snuffed out about 46 gigawatts, or about 40 per cent, of power-generation capacity in the state. (A megawatt is enough capacity to power about two hundred Texas homes.)*⁷ A similar situation, though on a smaller scale, occurred in Texas (United States) in 2011, where the cold weather at the beginning of February contributed to a decline in electricity production of around 29,000 megawatts of power. This resulted in power cuts for around 3.2 million customers.

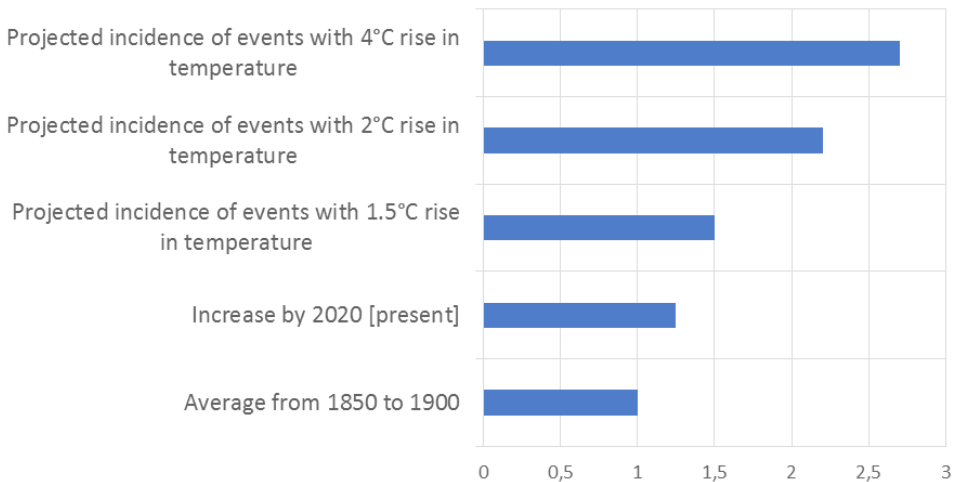
Hot weather, droughts, and fires have not only an economic and social dimension but also a biological one. An example is the fire that occurred in December 2020 in California (United States). As a result of 110,000 fires, nearly 10,500 buildings were damaged, and the area burned was more than four times larger than in similar fires that occurred from 2015 to 2019. Losses from forestland fires alone are estimated to be around USD 16 billion in the US in 2020. Another example showing the scale of losses is the fire that occurred in Australia in 2019 and 2020. It is estimated that more than 800 million animals died. Some of them were

7 <https://www.texasmonthly.com/news-politics/texas-blackout-preventable/> (accessed: 10 July 2024).

wild animals, which is a great and invaluable loss to the environment. The deaths of farm animals have caused losses to producers estimated at EUR 2 billion⁸.

The impact of drought on the functioning of the economy does not only affect the agricultural sector but also the energy sector. In the agricultural sector, droughts occurred on average once every 10 years between 1850 and 1900. Today, this happens 1.7 times more often. With a scenario of rising temperatures by 2050 (by 2 degrees Celsius), droughts are projected to occur 2.4 times more frequently than in the pre-industrial era (Figure 2). *Drought does not only mean agricultural losses. Hydrological drought causes a decrease in groundwater levels, which changes the geological conditions of individual areas. The disappearance of groundwater layers leads to the creation of voids, resulting in the risk of landslides and sinkholes. This phenomenon occurs on a large scale in France. As estimated by French insurers, between 2020 and 2050, the value of the damage on this account will be three times higher than in the thirty-year period 1989–2019.*⁹

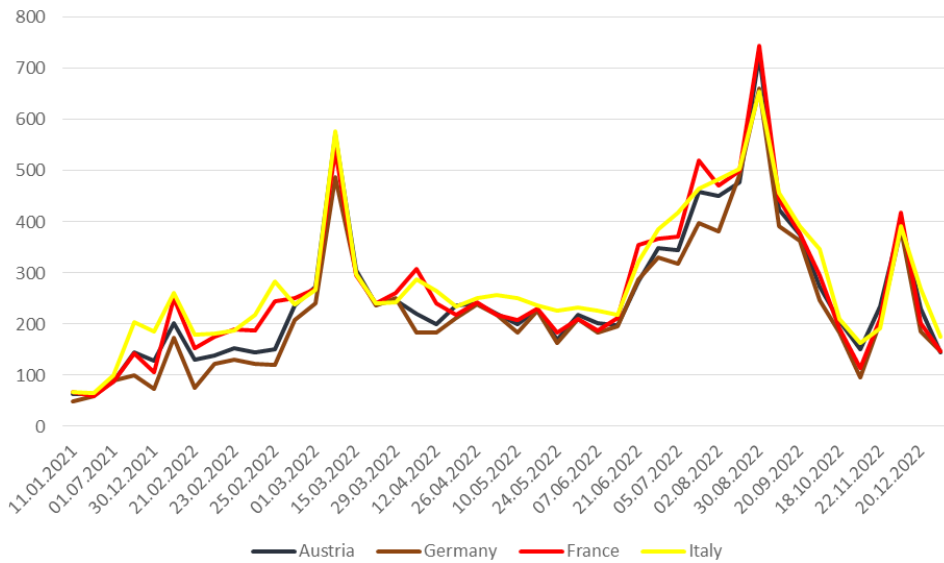
FIGURE 2. Increase in frequency of agricultural droughts likely to occur once in 10 years for selected regions of the world



Source: Internal analysis derived from: *Klimat rosnących strat. Rola ubezpieczeń w ochronie klimatu i w transformacji energetycznej* – rok 2023, Polska Izba Ubezpieczeń, EY, Warszawa, 2023, p. 18.

⁸ Everstream Analytics Special Reports – Bushfires in Australia.

⁹ *Klimat rosnących strat. Rola ubezpieczeń w ochronie klimatu i w transformacji energetycznej* – rok 2023, Polska Izba Ubezpieczeń, EY, Warszawa, 2023, p. 19.

FIGURE 3. Electricity price developments in 2021–2022 in Germany, France, Italy, and Austria

Source: Internal analysis derived from: Electricity prices Europe (www.euenergy.live).

Droughts also cause problems in the energy system as water is used in production processes (mainly in cooling processes) in hydro, conventional, and nuclear power plants¹⁰. The low state of rivers resulted in significant restrictions

¹⁰ In a nuclear power plant, water is used in the primary and secondary circuits. However, the technological process of a nuclear power plant requires the implementation of several important secondary circuits. The cooling water and technical water circuits for heat extraction from the turbine condensers and other process equipment play a much more important role than in a conventional power plant. First of all, in a system with saturated steam turbines (due to the lower steam parameters), the mass flow of cooling water, and therefore the capacity and power of the pumps, is about 50% higher than in a conventional power plant of the same output. In addition, significant amounts of heat are discharged from many process devices and rooms in a nuclear power plant. This applies to both normal operating conditions and emergency reactor shutdown, which requires some of the technical water pumps to be powered from independent emergency sources. A characteristic feature of a nuclear power plant is the need for an additional intermediate cooling circuit. This is a closed circuit used to remove heat from parts of the reactor primary circuit equipment that are in contact with the radioactive coolant. The intermediate circuit avoids radioactive substances entering the cooling water system, which is always associated with surface water. Source: Laudyn D., Pawlik M., Strzelczyk F., *Elektrownie*, Wydawnictwo Naukowo-Techniczne, Warszawa 2005, p. 399.

on the production of energy in hydroelectric and nuclear power plants. An example of the impact of water levels on electricity production is in Spain, where energy production was nearly 44 per cent lower in 2022 compared to 2021. In Italy, which produces around 20 per cent of its electricity using hydroelectric power plants, production from this type of generation source had to be reduced by nearly 40 per cent in 2022 due to low river levels¹¹. As a result, with the concurrent occurrence of the polycrisis (Russia's invasion of Ukraine), there was a sharp increase in energy prices (Figure 3). This means that an energy system based on water as the main energy carrier is not, and will not be, stable, which will make sustainable management difficult or impossible.

When analysing the economic and social impacts of natural disasters, it is clear that they are not only direct and do not only have an impact on the affected region. They also cause disruption to the functioning of the economic system, such as interruption or disruption to supply chains. This is why the impact of climate change, and thus of natural disasters, is of interest to researchers, including economists. In this regard, the green economics approach has identified at least several key paradigmatic models and approaches:

- ✦ **Greenhouse gas emission models and carbon footprint** – Models that calculate the amount of greenhouse gases, such as carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) emitted by industrial, transport, and agricultural activities. They enable the estimation of the carbon footprint for different economic sectors and the study of how emission reductions affect the climate. In green economics, they are often used to identify optimal strategies for reducing emissions, such as the development of renewable energy sources. An example of the practical application of this concept is the GHG Protocol, which *establishes a comprehensive, global, and harmonised framework to measure and manage greenhouse gas (GHG) emissions from private and public sector activities, value chains, and mitigation actions. The GHG Protocol provides the world's most widely used GHG accounting standards. The Corporate Accounting and Reporting Standard provides an accounting platform for virtually every corporate GHG reporting programme in the world.*¹²

¹¹ Climate change: Drought highlights dangers for electricity supplies, BBC, accessed: 12 July 2024 (<https://www.bbc.com/news/science-environment-62524551>).

¹² Ghgprotocol.org: What is GHG Protocol.

- ✦ **Computable General Equilibrium (CGE) models** – Simulation models that describe the interactions between the economy and the environment, taking into account the dynamic effects of climate policies. In CGE models, the structure of the economy, including demand, supply, prices, and production, is combined with an assessment of environmental costs. The models help to understand how the structure of the economy changes when green economy policies, such as carbon taxes or emissions trading schemes, are introduced. *CGE models, used in practice to analyse economic, energy, and environmental policies, rely on many trade-offs from the Walras General Equilibrium Theory. It is often recognised that such trade-offs bring the model closer to the real, imperfect world and increase its predictive power. CGE models, while preserving the general equilibrium structure, enable incomplete factor mobility, imperfect competition in some markets, unequal remuneration of factors across branches, and parameterisation of some traditionally endogenous variables (e.g., prices of some factors).*¹³
- ✦ **Carbon balance models and sequestration models** – Models that help determine how much carbon dioxide is put into the atmosphere by human activities and how much is sequestered by natural reservoirs, such as forests and oceans. Green economics uses these models to assess the effectiveness of green solutions, such as afforestation or Carbon Capture and Storage (CCS) technologies, in reducing net CO₂ emissions.
- ✦ **Damage function models** – Models that describe how changes in temperature and emissions affect the economy, health, and natural resources. A damage function is a mathematical expression that describes how a change in temperature affects economic costs, e.g., in agriculture or public health.
- ✦ **Dynamic Integrated Climate-Economy (DICE) model** – A model developed by William Nordhaus, one of the more comprehensive tools combining climate and economic modelling, particularly useful in green economics. The DICE model analyses the impact of climate policies on long-term economic growth and climate change. A key function in the model is a profit and loss equation that takes into account adaptation costs, investments, and climate damage. The DICE model calculates what the optimal economic pathway might look like when greenhouse gas emission reductions are introduced.

¹³ Kiuiła Olga. Obliczeniowe modele równowagi ogólnej (CGE); p. 113 <https://ekonomia.wne.uw.edu.pl/ekonomia/getFile/432>.

- ✦ **Marginal Abatement Cost (MAC) models** – Models that analyse the cost of reducing an additional unit of greenhouse gas emissions. They are used to determine the cost-effectiveness of policies that reduce emissions, such as emission charges or subsidies for green technologies. *Marginal abatement cost (MAC) curves have recently become a standard policy tool in assessing the economics of climate change mitigation options. This is because they provide a simple representation of the complexity of cost-effective emission reductions. The complexity of climate change mitigation and the diversity of stakeholders involved makes abbreviated communication, such as MAC curves, most useful. Furthermore, economic criteria have been highlighted and considered to be dominant in the political discussion (see e.g., DECC, 2009b). In this respect, the main policy question is how the emissions target can be achieved at minimum cost, while impacts on distributional equity, energy security, competitiveness effects, and secondary effects are of secondary importance.*¹⁴
- ✦ **A theoretical model of the macroeconomic impact of climate change and insurance** – The environmental economics literature provides extensive evidence that climate change affects the level of output and the ability of the economy to grow over the long term. This section models the role of insurance in mitigating the macroeconomic costs of climate change, distinguishing between the long-term effect of gradual but persistent changes in climate variables, such as temperature and precipitation (chronic physical hazards), and the short-term effect of more frequent and severe extreme weather events, such as floods, storms, droughts, and forest fires (acute physical hazards)¹⁵.

An example of this is the macroeconomic models that have been developed by researchers from the European Insurance Supervisory Authority (EIOPA) and the European Central Bank (ECB). One of the elements they highlight in their research is that the effects of extreme events, and thus the cost of their occurrence, may significantly increase (Table 1). This in turn will directly affect the economic and social situation of individual countries involved in catastrophic events.

14 Kesicki F, Strachan N., Marginal abatement cost (MAC) curves: confronting theory and practice, *Environmental Science & Policy*, Vol. 14, Issue 8, December 2011, Pages 1195.

15 Climate change, catastrophes and the macroeconomic benefits of insurance (europa.eu); JRC PESETA IV report: JRC PESETA IV (europa.eu), p. 4.

TABLE 1. Expected annual increase in costs of catastrophic events in Europe (EUR million) in the absence of action to adapt to climate change

	HISTORICAL AVERAGE (1981–2010)	2050 (TEMPERATURE INCREASE OF 1.5 °C) %, COMPARED TO HISTORICAL AVERAGE	2100 (TEMPERATURE INCREASE OF 2 °C) %, COMPARED TO HISTORICAL AVERAGE
Hurricanes	4,594	6,829 (49%)	6,913 (148%)
Droughts	9,048	12,354 (37%)	15,475 (248%)
River flooding	7,809	15,609 (100%)	21,268 (324%)
Coastal flooding	1,400	10,900 (679%)	14,100 (7,800%)
Total	22,851	45,692 (100%)	57,756 (716%)

Source: Internal analysis derived from: Climate change, catastrophes and the macroeconomic benefits of insurance (europa.eu); JRC PESETA IV report: JRC PESETA IV (europa.eu), p. 15.

An example of other research is a macroeconomic model that makes it possible to examine the impact of climate change on the economies of selected countries. Such a model was developed by the Swiss Re Institute¹⁶. It covers 48 selected countries (economies) of the world (accounting for 90 per cent of global GDP in 2019 in total). The ranking under the Climate Economics Index study (a part of the study with the CEI for the world's main economic and geographical regions) is presented in Table 2. It should be noted that economies in southern and south-east Asia are particularly vulnerable to the negative effects of climate change, while developed economies in the Northern Hemisphere are least vulnerable. The Climate Economics Index considers the impact on GDP of physical risks resulting from gradual changes in climate over time and vulnerability to extreme weather risks (wet and dry conditions). The index also shows countries' existing levels of adaptive capacity.

¹⁶ The economics of climate change: no action not an option, Swiss Re Institute, April 2021.

TABLE 2. Projected changes in GDP in the mid-21st century with different temperature rises and intensity of economic impact compared to a world without climate change

Temperature path	Well below 2 °C increase			2.0 °C increase			2.6 °C increase			3.2 °C increase				
	Paris target			The likely range of global temperature gains						Severe case				
Omitted channels	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
(Un)known unknowns	X	✓ x5	✓ x10	X	✓ x5	X	✓ x5	X	✓ x5	X	✓ x10	X	✓ x5	✓ x10
World	-0.5%	-2.2%	-4.2%	-1.3%	-5.7%	-11.0%	-1.7%	-7.2%	-13.9%	-2.2%	-9.4%	-2.2%	-9.4%	-18.1%
OECD	-0.4%	-1.6%	-3.1%	-0.8%	-3.9%	-7.6%	-0.9%	-4.1%	-8.1%	-1.1%	-5.4%	-1.1%	-5.4%	-10.6%
North America	-0.5%	-1.7%	-3.1%	-0.9%	-3.7%	-6.9%	-1.0%	-4.0%	-7.4%	-1.2%	-5.1%	-1.2%	-5.1%	-9.5%
South America	-0.4%	-2.0%	-4.1%	-1.1%	-5.5%	-10.8%	-1.4%	-6.6%	-13.0%	-1.8%	-8.6%	-1.8%	-8.6%	-17.0%
Europe	-0.2%	-1.4%	-2.8%	-0.7%	-3.8%	-7.7%	-0.8%	-4.0%	-8.0%	-1.0%	-5.2%	-1.0%	-5.2%	-10.5%
Middle East & Africa	-0.7%	-2.5%	-4.7%	-2.4%	-7.6%	-14.0%	-4.6%	-12.1%	-21.5%	-5.2%	-15.0%	-5.2%	-15.0%	-27.6%
Asia	-0.7%	-2.8%	-5.5%	-1.7%	-7.7%	-14.9%	-2.4%	-10.5%	-20.4%	-3.0%	-13.7%	-3.0%	-13.7%	-26.5%
Advanced Asia	-0.4%	-1.7%	-3.3%	-1.1%	-4.8%	-9.5%	-1.3%	-5.9%	-11.7%	-1.7%	-7.7%	-1.7%	-7.7%	-15.4%
ASEAN	-0.8%	-2.3%	-4.2%	-2.4%	-9.0%	-17.0%	-4.1%	-15.4%	-29.0%	-5.0%	-19.7%	-5.0%	-19.7%	-37.4%
Oceania	-0.5%	-2.2%	-4.3%	-1.3%	-5.8%	-11.2%	-1.7%	-6.5%	-12.3%	-2.0%	-8.3%	-2.0%	-8.3%	-16.3%

Source: Internal analysis derived from: The economics of climate change: no action not an option, Swiss Re Institute, April 2021, p. 11.¹⁷

¹⁷ It should be noted that the temperature rises that were the basis for the Climate Economics Index are for the period from pre-industrial times to mid-century. Column labels indicate specific changes in the variables in the presented scenario analysis: the inclusion of omitted channels (i.e., channels that have not been quantified in previous studies) and multiplicative factors (x5 and x10) for the potentially increased severity of unknown unknowns. Source: Swiss Re Institute.

6.2. Towards new ideas for the functioning of the economy – sustainable development, green economy, and circular economy

With climate change, researchers do not only highlight the significance of climate change and its impact on humanity's continued existence but also look for the causes of this phenomenon and ways to reduce it. Economic researchers decided that a good basis for the research would be the broad concept of sustainability. The discussion on sustainable development was initiated because it was recognised that actions of mankind were creating a threat to the basis of human life due to the overexploitation of resources, which had previously been treated as commodities available in infinite quantities. In 1972, the first United Nations conference on environmental issues was held in Stockholm. The conference discussed the question of whether *humanity and the economy are moving towards a point where their natural basis is in danger of being exhausted. All countries of our globe start to realise that the long-term and uninterrupted improvement of the living conditions of the world's growing population is only possible if we choose to sustain the natural basis of life.*¹⁸

This discussion led to an increased awareness among policy makers and researchers about the role of resources and a revision of existing economic models. At the 1992 United Nations conference in Rio de Janeiro, new guidelines for the development of the world's leading economies were agreed. The new development guidelines were collectively referred to as sustainable development¹⁹. All international organisations and countries accepted the new model. The European Union included this concept in its founding treaty, while countries such as Germany or Poland enshrined it in their constitutions. For Poland, the concept of sustainable development appears in Article 5 of the Basic Law, which states that *the Republic of Poland shall safeguard the independence and integrity of its territory,*

¹⁸ Rogall H., *Ekonomia zrównoważonego rozwoju. Teoria i praktyka*, Zysk i S-ka Wydawnictwo, Poznań 2010, p. 39.

¹⁹ *The term "sustainability" derives from the term "sustain" derived from the Latin sustinere meaning "to preserve." The term "development" encompasses a number of objectives. In the past, different disciplines developed different theories on the subject. As early as the 16th century, the Rhineland-Palatinate forest code stated that only as many trees as can grow back should be felled so that there is no shortage of wood for posterity – the availability of wood should not be permanently reduced. In this way, the demand for the preservation of ecological real capital was justified. In German forestry, sustainability has been raised regularly since the 18th century. It was first mentioned in documents from 1780.* Source: Rogall H., *Ekonomia zrównoważonego rozwoju. Teoria i praktyka*, Zysk i S-ka Wydawnictwo, Poznań 2010, p. 40.

ensure freedoms and rights of persons and citizens and the security of its citizens, safeguard its national heritage, and ensure the protection of the natural environment pursuant to the principles of sustainable development.

However, in spite of such declarations, most economies fail to live up to and implement the principles adopted and advocated at the 1992 Rio de Janeiro Conference. One of the first important elements contributing to this was the lack of a uniform and unambiguous definition of this concept and what is the core behind it. The attempt to transfer a definition of this concept directly from forest management to scientific and economic practice was controversial. Another questionable element was the understanding and application of the concept of development. No one disputed the postulates related to development, which was defined as the pursuit of expected or even desired goals, *e.g.*, related to education standards, improving the health of humanity, or improving the food situation. The concept was also understood as permanently sustained development or development that is secure for the future. Experts on environmental issues, including environmental economics, understood sustainability as development that is permanently safe for the environment.

Another controversy was around the scope that sustainable development policies were to cover. When the objectives of the policies were narrowly formulated, there was a risk that the model would only be used by those with an interest in environmental issues. When attempts were made to apply a broad approach, there was a danger that a sustainable development policy may become synonymous with a policy devoid of substance. Therefore, it is difficult to identify a single definition of sustainable development that is widely used around the world. *According to the Brundtland Commission, sustainable development is development that meets the needs of the present without the risk that future generations will not be able to meet their needs. According to the new environmental economics (the definition recommended for the economics of sustainable development), sustainable development seeks to ensure that all people living today and future generations will be able to meet sufficiently high ecological, economic, and socio-cultural standards within the limits of the Earth's natural resilience by applying the principle of intra- and intergenerational equity.*²⁰ This problem can be also seen in further concepts of new economic models – the green economy and the circular economy.

However, the various uncertainties about a single common definition of sustainable development did not prevent the idea from being developed and

20 *Ibid.*, p. 44.

implemented. In 2015, the 2030 Agenda for Sustainable Development was developed and adopted by all United Nations Member States. Its 17 main sustainable development goals (SDGs) are as follows:

1. No poverty (End poverty in all its forms everywhere)
2. Zero hunger (End hunger, achieve food security, and promote sustainable agriculture)
3. Good health and well-being (Ensure healthy lives and promote well-being for all)
4. Quality education (Ensure inclusive and equitable quality education and promote lifelong learning)
5. Gender equality (Achieve gender equality and empower all women and girls)
6. Clean water and sanitation (Ensure availability of water and sanitation for all)
7. Affordable and clean energy (Ensure access to affordable, sustainable, and modern energy for all)
8. Decent work and economic growth (Promote inclusive economic growth, productive employment, and decent work for all)
9. Industry, innovation, and infrastructure (Build resilient infrastructure, promote sustainable industrialisation, and foster innovation)
10. Reduced inequality (Reduce inequality within and among countries)
11. Sustainable cities and communities (Make cities and human settlements inclusive and safe)
12. Responsible consumption and production (Ensure sustainable consumption and production patterns)
13. Climate action (Take urgent action to combat climate change and its impacts)
14. Life below water (Conserve oceans, seas, and marine resources)
15. Life on land (Protect sustainable terrestrial ecosystems and biodiversity)
16. Peace justice, and strong institutions (Promote peaceful and inclusive societies and strong and accountable institutions)
17. Partnerships for the goals (Revitalise the global partnership for sustainable development)²¹

Based on this understanding of the nature and importance of the concept of sustainable development, 17 main goals were set and subdivided into targets. They were the impetus for the development of new ideas that gradually developed

²¹ 2030 Agenda for Sustainable Development – implementation in Poland. Sustainable development goals, Ministry of Development, Warszawa 2019, p. 4.

into concepts that seek to tackle sustainable development goals. Nevertheless, it seems that the goals continue to pay attention to existing problems. For some goals, it may be debatable whether they will be achieved by 2030 when confronted with current geopolitical and environmental context. An example is SDG 2 relating to the fight against hunger and the promotion of sustainable agriculture. *After rising sharply from 2019 to 2021, global hunger, measured by the prevalence of undernourishment (PoU), has persisted at nearly the same level for three consecutive years, still affecting 9.1 per cent of the population in 2023 compared with 7.5 per cent in 2019. It is estimated that between 713 and 757 million people, corresponding to 8.9 and 9.4 per cent of the global population, respectively, may have faced hunger in 2023. Considering the mid-range (733 million), this is about 152 million more people than in 2019. Going beyond hunger, the prevalence of moderate or severe food insecurity remains above pre-pandemic levels, with little change in four years. In 2023, an estimated 28.9 per cent of the global population – 2.33 billion people – were moderately or severely food insecure, meaning they did not have regular access to adequate food. These estimates include 10.7 per cent of the population – 864 million people – who were food insecure at severe levels, posing grave risks to their health and well-being. The world is not on track to achieve any of the seven global nutrition targets by 2030.*²²

The green economy and the circular economy are examples of the above-mentioned ideas, gradually finding their way into practice. They have enabled the launch of new methodological areas, originating from the natural and mathematical sciences, in the research approach to how to manage resources appropriately.

They have been gradually evolving and gaining prominence in the last decades of the 20th century and in the 21st century. Concepts related to the green economy and the circular economy, in a broader sense, are beginning to be a part of various types of policies. A major area of interest is the move towards a low-carbon, resource-efficient, and inclusive economy. This approach contradicts the hitherto dominant paradigm of the linear model of economy.

The linear model of the economy is based on the “make, use, dispose” consumption pattern. This pattern contradicts the that particular resources are limited. Increased demand for certain basophilic products makes them available only to a limited, wealthy, group of people. The increased ability to meet the needs of the world’s affluent population generates pressures to actively harvest natural resources.

²² The State of Food Security and Nutrition in the World 2024, Food and Agriculture Organisation of the United Nations, Rome, 2024, pp. 19–22.

The linear model of resource consumption that was established during industrialisation boiled down to the use of the end-of-life concept. In this concept, companies obtain materials and raw materials and then use them to create a product. The product is sold to consumers, who use it until they meet their requirements (resulting from fashion, technological developments, etc.) and throw it away. *There is widespread agreement that the linear economy should be ended and not necessarily on what to use instead: eco-design, recycling, short cycles, resource efficiency, etc. Reintroducing end-of-life materials into the economic cycle and replacing the end-of-life concept with restoration is one of the principles of the circular economy. It seeks to eliminate waste (and other emissions to the environment) through excellent design of materials, system products, and business models. A waste from one production process becomes a raw material in another process. Thus, the circular economy is conceived as the transformation of material streams into cycles that minimise material consumption, energy flows, and environmental impacts without compromising economic, social, and technical progress.*²³ It should be noted that there is no single agreed definition of the circular economy to date²⁴. Moreover, there is no consensus on the scope of terminology and definitions used by researchers, practitioners, and policy makers. However, the applicability of this concept in practice and its limitations seem to be a much greater challenge.

At the beginning of the 21st century, there was a significant interest in the idea of the circular economy in Asian countries. A particular attention should be placed on descriptions and measures taken in the Chinese economy and in some Asian countries. *In particular, they are promoting diverse forms of industrial symbiosis between economic actors using different production processes, minimising the use of primary resources and implementing cleaner production principles. In China, the circular economy was introduced into national policy as early as 2002 as an idea of respect for the environment rather than an environmental management system. The activities were coordinated through the National Development and Reform Commission. As a result, in 2005, China, faced with limited resources and high energy consumption, implemented a new national strategy for the circular economy. The strategy sought to achieve high resource and energy efficiency through "reduction, reuse, and recycling" (Yuan et al. 2006; Zhang et al. 2009). China's circular economy encompasses both waste*

23 Hausner J., Krzykowski M., *Gospodarka i entropia. Jak wyjść z polikryzysu?*, Wydawnictwo Naukowe Scholar, Warszawa 2023, p. 62.

24 An overview of the 14 definitions of a closed-loop economy is presented by Kulczycka J., *Gospodarka o obiegu zamkniętym w polityce i badaniach naukowych*, Wydawnictwo IGSMiE PAN, Kraków 2019, p. 13.

management issues (the 3Rs principle) and the resources needed for economic development. For China, the circular economy has become a new sustainable development strategy that integrates cleaner production and industrial ecology, taking into account long-term planning through, among others, the implementation of tools and principles, including the creation of industrial eco-parks. These solutions encouraged the organisation of economic activities using feedback processes that mimic natural ecosystems through the following cycle: natural resources → transformation into manufactured products → by-products used as resources for other industries.²⁵

In 2015, the Ellen MacArthur Foundation proposed a new version of the definition of the circular economy. *The circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources.²⁶*

This definition is currently considered the leading one. The circular economy seeks to keep products, components, and materials in a state of utmost usefulness and value over time, distinguishing between technical and biological cycles. This new economic model tries to finally decouple global economic development from the unsustainable consumption of natural resources.

This is an important aspect if the ideas of the circular economy are to be introduced and implemented in the real economy. As a result, there is a gradual evolution, mainly to move away from narrow waste management approaches towards preventive and integrated approaches. This approach emphasises the life cycle of materials and products, thereby increasing the efficiency of use of raw materials and materials. There is a growing drive to close material cycles as well as intensify and increase the efficiency of industrial recycling of the materials that can be used in production processes while minimising their waste. This requires a combination of the development of new business models and the formation of circular economy value chains, which should include producers and consumers of a particular product, from the designer to the consumer/end user of the product.

²⁵ Source: Kulczycka J., *Gospodarka o obiegu zamkniętym w polityce i badaniach naukowych*, Wydawnictwo IGSMiE PAN, Kraków 2019, p. 11.

²⁶ Ellen MacArthur Foundation, *Circular economy introduction*, <https://www.ellenmacarthurfoundation.org/topics/circular-economy-introduction/>

The transition to the circular economy is a systemic change that affects the entire economy involving all products and services occurring at all stages of value chains. It necessitates paradigm shifts in the functioning of the economy and in the business models adopted by businesses and a change in the way consumption and resources are managed at the household level.

6.3. The circular economy and its impact on the formulation of economic policies and objectives

The circular economy operates at macro, meso, and micro levels. The macro level includes national economies, states, such as China, and supranational entities, such as the European Union. The meso level in the circular economy focuses on economic activity sectors, industries, cities, and eco-industrial parks, networks, and clusters. The micro level includes consumers, households, businesses as well as products and services. This division shows the different, current and future, stakeholders in the processes of implementing the circular economy.

At the macro level, governments are considered to be the main stakeholders. They identify, formulate, and define policy objectives and boundary conditions, conducive to economic and social change and ensuring the coherence of the policies, to make it possible to introduce the circular economy and increase the efficient use of available resources and raw materials. Examples of such policies are the actions taken by the Chinese authorities, the European Commission, the USA, and Australia.

The Chinese authorities have defined the importance and role of the circular economy in the 14th Five-Year Plan (2021–2025) approved by the National People's Congress on 11 March 2021. The document covers the period until 2035 and focuses on three core elements:

1. Striving for high quality development based on science and support for environmental protection combined with coordination and high level of development processes.
2. Enhancement of endogenous growth factors.
3. Continuous building of a moderately prosperous society.

The 14th Five-Year Plan is a continuation of the 13th Five-Year Plan for the main priorities. A thing that is new is that the focus is placed on quality of development rather than quantitative growth of the economy. One of the manifestations of this approach is the development of the circular economy. The main objectives in the area of green economy and circular economy are shown in Table 3.

TABLE 3. Goals of the 14th Five-Year Plan for the circular economy

CIRCULAR ECONOMY INDICATORS	GOALS IN 2025
Resource productivity	Increase by 20% compared to the level in 2020
Energy consumption	Reduce per unit of GDP by 13.5% compared to the level in 2020
Water consumption	Reduce per unit of GDP by 16% compared to the level in 2020
Waste utilisation	86% of crop stalks
	60% of construction waste
	60% of bulk solid waste
	60 million tonnes of waste paper
	320 million tonnes of scrap steel
Production of recycled materials	20 million tonnes of recycled non-ferrous metals
Output value of the resource recycling industry	Increase the value to RMB 5 trillion (USD 773 billion)

Source: Internal analysis derived from: China's Circular Economy Transition – Challenges and Solutions Ahead. A Circular Economy Vision, Issue No. 6, Circular Innovation Lab, Copenhagen, 2023, p. 4.

In undertaking the goals set out in the 14th Five-Year Plan, it was decided to implement a number of projects, the coordination of which is the responsibility of the National Development and Reform Commission. Keeping in mind the issues of environmental protection as well as the green economy and the circular economy, particular groups of projects identified in the plan have been assigned to the macro, meso, and micro levels (Table 4).

TABLE 4. Projects identified in the 14th Five-Year Plan and their breakdown into micro, meso, and macro levels

LEVEL	CE PROJECTS	SCOPE OF IMPLEMENTATION
Micro	<ul style="list-style-type: none"> ✦ Improvement of the quality of waste electrical and electronic products ✦ Promotion of automobile use lifecycle management ✦ Special action for the whole chain of plastic pollution control ✦ Green transformation of express packaging ✦ Recycling action of waste power batteries ✦ Improvement of the circular economy statistical evaluation system 	Product
Meso	<ul style="list-style-type: none"> ✦ Demonstration project of resource utilisation of construction waste ✦ Key technology and equipment innovation project of the circular economy ✦ High-quality development of the remanufacturing industry 	Industry
Macro	<ul style="list-style-type: none"> ✦ Construction project of urban waste material recycling system ✦ Circular development project of the industrial parks ✦ Demonstration project of comprehensive utilisation of bulk solid waste 	Country

Source: Internal analysis derived from: China's Circular Economy Transition – Challenges and Solutions Ahead. A Circular Economy Vision, Issue No. 6, Circular Innovation Lab, Copenhagen, 2023, p. 10.

The projects shown in Table 4 include the preparation and implementation of a new comprehensive urban waste recycling system and the preparation of delivery points, transfer stations, and sorting centres for urban waste in nearby communities, supermarkets, schools, and offices. Attention should also be placed on the circular development project for industrial parks. The aim of this project is to promote the use of distributed energy storage and photovoltaic energy systems, centralised wastewater collection, and material flow management. Demonstration projects, comprehensively utilising solid bulk waste, focus on fly ash, coal fly ash, metallurgical slag, industrial by-product gypsum, and other wastes. The aim of the demonstration project of resource utilisation of construction waste is to establish 50 demonstration cities for the use of construction waste sources. Specific activities include promoting construction waste source reduction, establishing a construction waste classification system, and standardising

the construction and operation of construction waste disposal sites.²⁷ It is worth noting that green economy and circular economy projects provide an impetus for R&D activities to develop innovative products or processes that can help achieve the set goals. Moreover, they have an impact on the energy transition process and the creation of a new paradigm in the changing energy system based on renewable energy sources.

The changes bring new challenges, including in particular those generating high costs of demonstration projects for new technologies and economic and organisational processes. One of the biggest challenges is the lack of appropriately educated and prepared human resources (employees, specialists, experts, and managers). In particular, there is a need to develop education at university and polytechnic level in the broadly defined circular economy and green economy. Only a staff that is well educated and understands the importance of economic transformation processes is able to bring the change processes to a successful conclusion and achieve the goals set.

The European Union has a similar view in the importance of the green economy and the circular economy. Circular economy issues have been of interest to researchers and policy makers since the beginning of the 21st century. As the effects of climate change became increasingly apparent, the need for changes in the way we think and manage across all EU member states began to be recognised. This approach is reflected in the European Green Deal, the main ideas of which were presented on 11 December 2019. From its adoption until 2024, a total of 108 initiatives²⁸ in line with the green economy and the circular economy concepts have been launched. A more detailed summary of the initiatives is shown below:

- ✦ 2019 – a presentation of the European Green Deal and launch of initiatives.
- ✦ 2020 – a total of 11 initiatives, including in particular the European Industrial Strategy, the Strategy for the Integration of Energy Systems and Hydrogen Sector, the Methane Strategy, and the Roadmap for a Closed Economy.

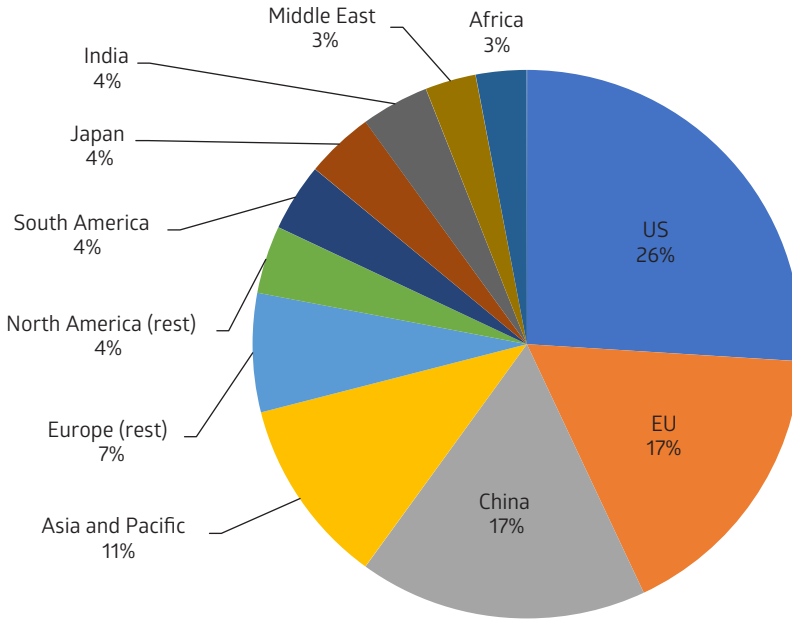
²⁷ China's Circular Economy Transition – Challenges and Solutions Ahead. A Circular Economy Vision, Issue No. 6, Circular Innovation Lab, Copenhagen, 2023, p. 10.

²⁸ Initiatives should be understood as a set of all activities that have been undertaken in the EU, ranging from the presentation of ideas for certain legal solutions and the preparation or modification of existing directives and regulations to the establishment of partnerships in the implementation of certain policies, e.g., related to the acquisition of critical materials. The analysis of initiatives has been prepared based on the following data:https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_pl.

- ✦ 2021 – a total of 11 initiatives, including in particular the European Battery Alliance, the European Climate Pact, and the New EU Climate Change Adaptation Strategy.
- ✦ 2022 – a total of 18 initiatives, including in particular the REPowerEU Plan (affordable, secure, and sustainable energy for Europe), initiatives for new legislation on cleaner air and cleaner water, a proposal for new Euro 7 standards to reduce vehicle emissions and improve air quality, new legislation on the application of the EU Emissions Trading Scheme to the aviation sector, and the regulation on packaging and packaged waste.
- ✦ 2023 – a total of 33 initiatives, including in particular Fit for 55, new legislation on alternative fuels infrastructure, political agreement on modernising industrial emissions management, new legislation to improve the energy performance of buildings across the EU, updated EU legislation on decarbonising the gas market and creating a hydrogen market, and a more sustainable and resilient trans-European transport network.
- ✦ 2024 – 34 initiatives, including in particular the adoption of a strengthened directive on the energy performance of buildings, entering into a strategic partnership with Uzbekistan on critical raw materials, entering into a strategic partnership with Norway on sustainable land-based raw materials and battery value chains, and signing a memorandum of understanding between the EU and Rwanda on sustainable raw material value chains.

The main areas to support economic development and put the green economy into practice in the EU include transport, energy, industry, environment and oceans, regional development and finance, climate, agriculture, and the new European Bauhaus. The tasks and objectives of the various initiatives, strategies, directives, and regulations that have been implemented within the EU are similar to initiatives in other countries that have a significant impact on the global economy (Figure 4).

FIGURE 4. Share of selected economies in global GDP [GDP at current prices, 2023]



Source: Internal analysis derived from: The future of European competitiveness. Part A. A competitiveness strategy for Europe, September 2024, p. 7.

The European Union and China are not the only representatives of the global economy who have joined the whole process of changes relating to the green economy. Similar activities are being undertaken in the USA, Korea, Japan, India, Canada, and Australia (Table 5). In principle, most of the activities aimed at changes in economic processes related to decarbonisation require special political and administrative care. The decarbonisation processes of the economy affect energy prices, the identified types of generation sources, and energy-intensive industries, *i.e.*, transport, heavy industry machinery, and the IT sector. On the other hand, the ongoing changes related to decarbonisation affect the competitiveness of individual industries and economic sectors and thus have an impact on the competitive position of an economy. Companies in the US and China have lower costs for electricity (Figure 5) and natural gas (Figure 6). To remain competitive, Europe needs to reduce energy prices. However, it cannot stop the processes of decarbonisation, energy transition, and introduction of the circular economy.

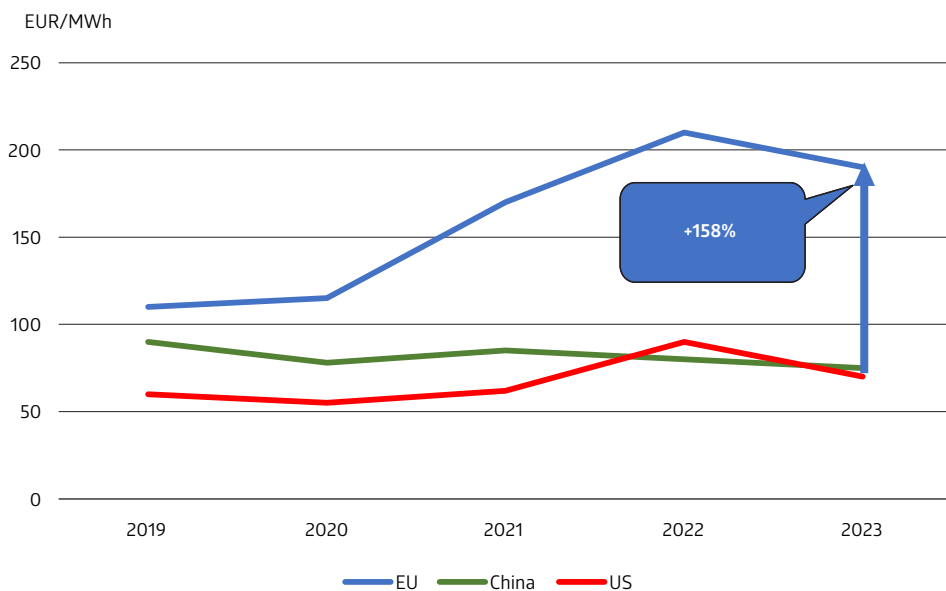
TABLE 5. Examples of national schemes to encourage the development of processes and technologies related to the green economy and, in particular, energy transition (from 2020 onwards)

	DIRECT INCENTIVE SCHEMES	BUDGET (BILLION USD)	TECHNOLOGIES COVERED
United States	<ul style="list-style-type: none"> ✦ Inflation Reduction Act ✦ Infrastructure Investment and Jobs Act ✦ Presidential Determination Pursuant to Section 303 of the Defense Production Act 	51	Solar PV, wind, batteries, critical minerals, low-emissions vehicles, heat pumps, hydrogen
Canada	<ul style="list-style-type: none"> ✦ Clean Economy Investment Tax Credits, Net Zero Accelerator Initiative ✦ Strategic Innovation Fund ✦ Canada Growth Fund 	34	Hydrogen, batteries, low-emissions vehicles, renewable energy, critical minerals, CCUS, clean electricity, clean technology, clean technology manufacturing
China	<ul style="list-style-type: none"> ✦ New Energy Vehicle Promotion and Application Subsidy Funds [Disbursed through manufacturers] 	26	Batteries, low-emissions vehicles
Australia	<ul style="list-style-type: none"> ✦ Future Made in Australia Plan ✦ Hydrogen Headstart ✦ Powering Australia 	13	Batteries, critical minerals, low-emissions hydrogen, renewable energy
India	<ul style="list-style-type: none"> ✦ Production-linked Incentive Scheme ✦ National Hydrogen Mission ✦ Scheme for Viability Gap Funding 	12	Solar PV, low-emissions vehicles, batteries, hydrogen
Japan	<ul style="list-style-type: none"> ✦ Economic Security Promotion Act, including capital investment subsidies for battery production ✦ GX Green Transformation Policy 	3	Batteries, biofuels, wind, solar PV
Korea	<ul style="list-style-type: none"> ✦ Semiconductor Industry Comprehensive Support Plan ✦ Battery Industry Innovation Strategy 	1	Batteries, low-emissions vehicles

Source: Internal analysis derived from: World Energy Outlook 2024, IEA, p. 84.

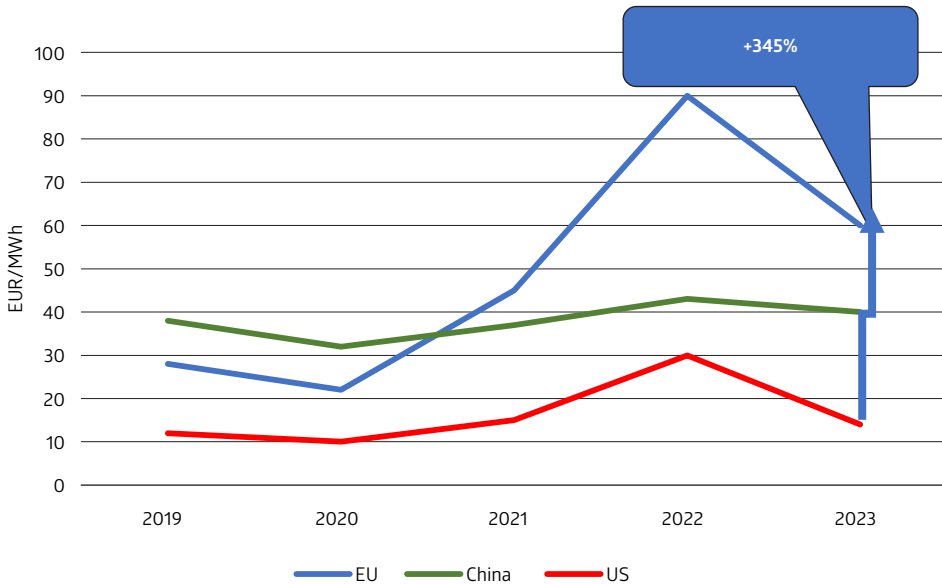
In the EU, natural gas prices are 4–5 times higher than in the US and electricity prices are 2–3 times higher than in the US. This creates new challenges in carrying out the decarbonisation process and energy system transformation as well as developing and implementing innovations in this area.

FIGURE 5. Industrial retail power price – price gap between the EU, China, and the US



Source: Internal analysis derived from: The future of European competitiveness. Part A. A competitiveness strategy for Europe, September 2024, p. 11.

Similar challenges exist in the US and Chinese economies. However, they significantly differ in the approach to achieving the identified goals. An example of the differences in the approach to maintaining the competitiveness of the economy is the innovation-related activities and expenditures and the innovativeness of the economy. China and the US implement the activities more effectively than the EU due to several weaknesses that are currently apparent in the EU. According to the diagnosis made by M. Draghi, the EU *does not have a sufficient number of academic institutions reaching the highest level of excellence and the path from innovation to commercialisation is weak. Universities and other research institutions play a key role in early-stage innovation, generating breakthrough research and creating new skills profiles in the workforce. Europe*

FIGURE 6. Industrial gas price – price gap between the EU, China, and the US

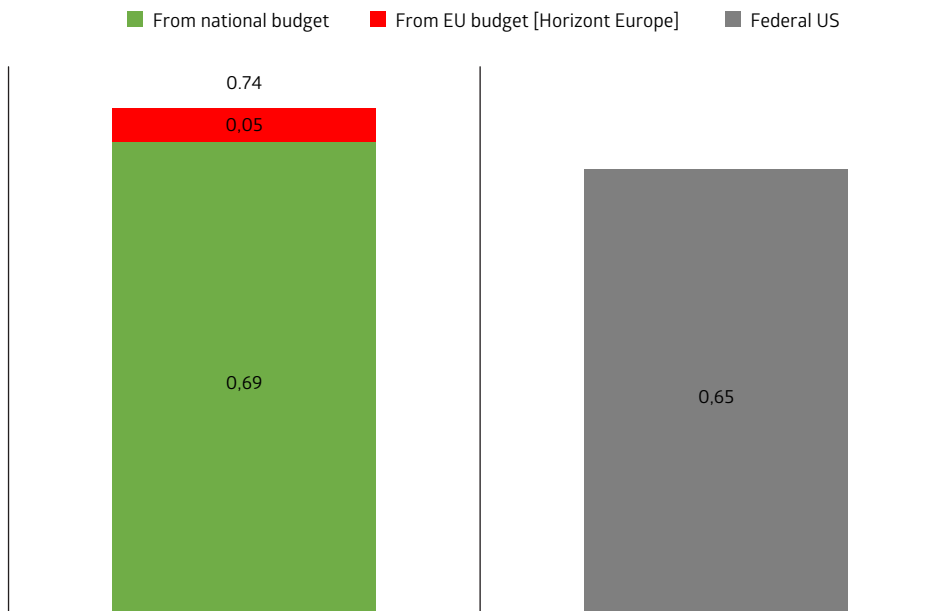
Source: Internal analysis derived from: The future of European competitiveness. Part A.A competitiveness strategy for Europe, September 2024, p. 11.

has a strong position in basic research and patents. In 2021, it accounted for 17 per cent of global patent applications, compared to 21 per cent for the US and 25 per cent for China. Universities operating in Europe, on the other hand, are not at the top of the world rankings, they are in middle positions. On average, an insufficient number of universities and research institutions are at the top of the list. Assuming the number of publications in leading academic scientific journals as an indicative criterion, the EU has only three research institutions ranked in the top 50 in the world, compared to 21 for the US and 15 for China. The EU's innovation stock is also weaker at the commercialisation stage of basic research. Much of the knowledge produced by European researchers remains unused commercially. Only about a third of patented inventions registered by European universities or research institutions are used commercially (...). Europe has no innovation "clusters" in the world's top 10, compared to 4 for the US and 3 for China.²⁹

²⁹ The future of European competitiveness. Part A.A competitiveness strategy for Europe, September 2024, p. 25.

In some comparable areas, public spending on research and innovation in the EU can be compared with that of the US. The comparison shows that spending on research and disruptive innovation in Europe is insufficient. The EU is strong in the incremental development of industries, without the use of the latest technologies. Activities in the EU do not focus on the preparation and implementation of breakthrough or even disruptive innovations. The comparison of research and innovation spending between the EU and the US shows that the amounts spent are generally at a similar level (based on 2021 data as shown in Figs. 7 and 8). A significant difference is how the funds are spent. In the EU, a significant funding (EUR 100 billion) has been allocated to Horizon Europe. The amount has been “spread” over many areas of science and technology. Moreover, complicated bureaucratic procedures have been applied. For schemes focusing on breakthrough innovations, based on radical technologies, with the low Technological Readiness Level (TRL) in the EU, there is the Pathfinder of the European Innovation Council (EIC) with a budget of EUR 256 million for 2024. As

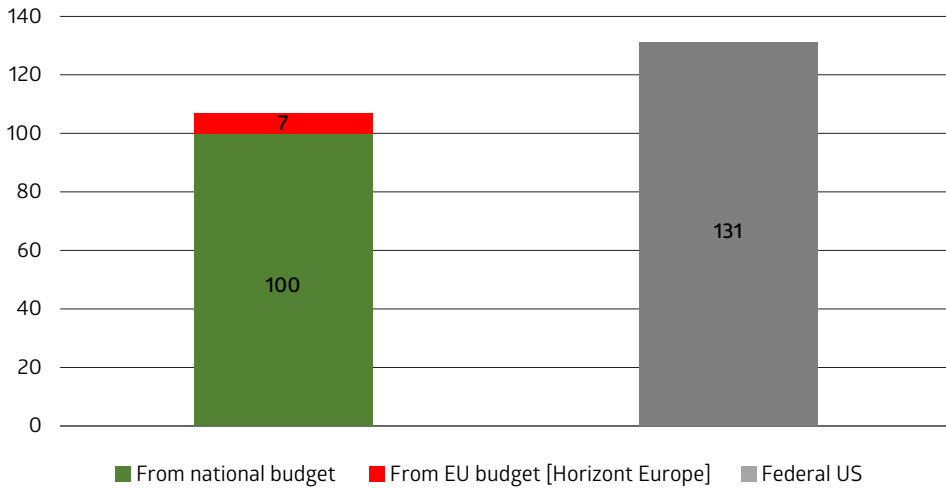
FIGURE 7. State versus federal sources of R&D funding in the EU and the US [per cent of GDP, 2021]



Source: Internal analysis derived from: The future of European competitiveness. Part A. A competitiveness strategy for Europe, September 2024, p. 25.

noted by M. Draghi in his report, the funds are managed by officials rather than experts with market experience and scientists.

FIGURE 8. State versus federal sources of R&D funding in the EU and the US EUR billion, 2021]



Source: Internal analysis derived from: The future of European competitiveness. Part A. A competitiveness strategy for Europe, September 2024, p. 25.

The U.S. Defence Advanced Research Projects Agency (DARPA) is allocating USD 4.1 billion for a similar purpose, *i.e.*, breakthrough innovations, including those related to decarbonisation, energy transformation and new digital technologies, and another USD 2 billion for the other ARPA agencies. In the US, there are better conditions for accessibility to the VC sector resulting, among others, in many innovative companies from all over the world, including the EU, expanding into the US market. An example is the funding for the development of AI technology companies: *61 per cent of the total global funding for AI start-ups goes to US companies, compared to 17 per cent for China and only 6 per cent for the EU. For quantum computing, EU companies attract only 5 per cent of global private funding, compared to 50 per cent for US companies.*³⁰

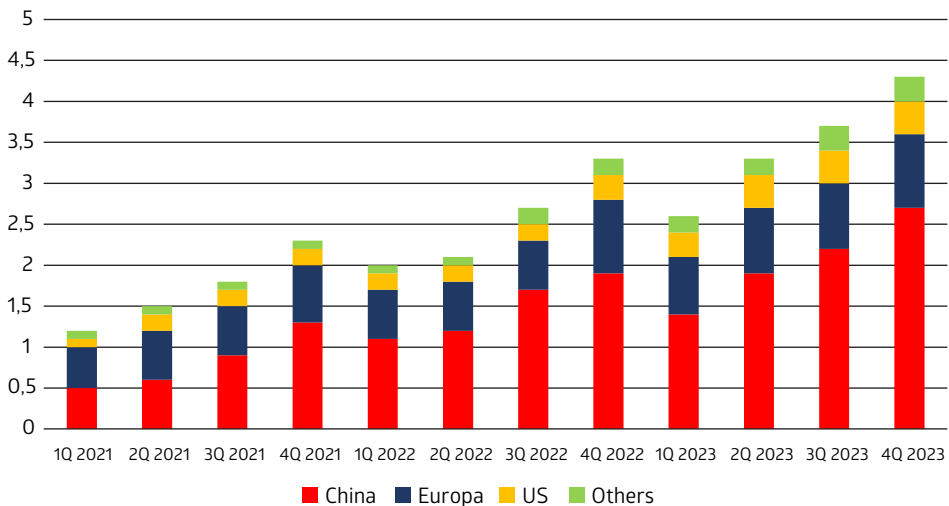
Another problem for the EU in relation to the operation of technology companies in the US is legal and regulatory barriers. In the EU, complex and costly

³⁰ Ibid., p. 26.

IPR filing procedures are a barrier and this is due to fragmented national systems, among others. The regulations that currently operate in the EU hinder innovation: *there are currently around 100 technology-focused regulations and over 270 digital network regulators across all Member States.*³¹

Decarbonisation, the energy transition, the green economy, and the circular economy are all opportunities for leadership for decades to come. This is particularly true in the field of new clean technologies and the efficient use of raw materials, including recycled ones. Even now, it is already clear that competition in this area is intensifying, with China now starting to take the lead in key industries, in particular in the production of batteries, electric cars, wind farm installations, and solar panels. The European market is currently the second largest in the world in terms of demand for electric vehicles (Figure 9). In contrast, China, Korea, the USA, and Japan are the leading manufacturers and importers of EVs in 2021–2022.

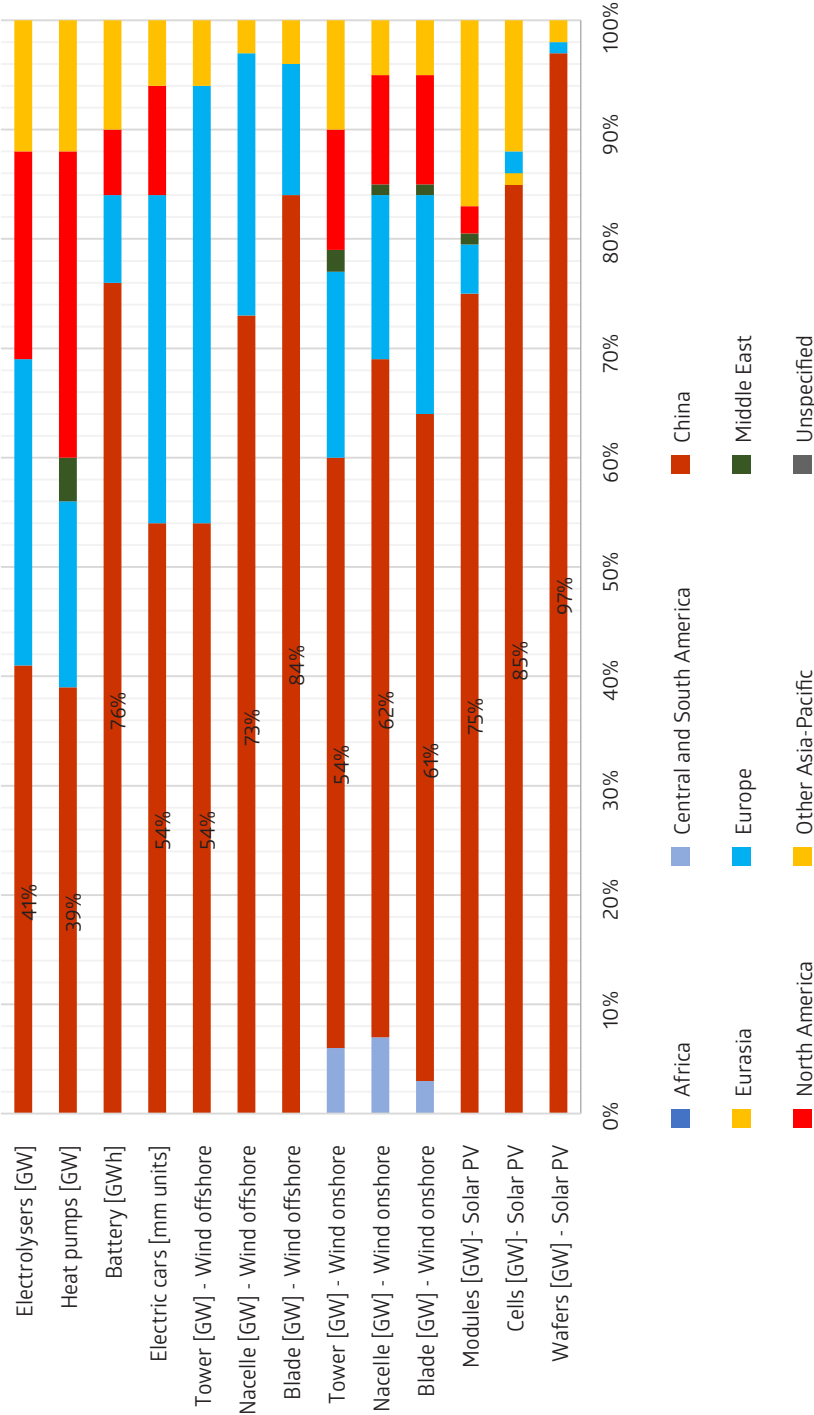
FIGURE 9. Quarterly electric car sales by region from 2021 to 2023 (in millions of units)



Source: Internal analysis derived from: IEA (2024), Quarterly electric car sales by region, 2021–2024, IEA, Paris <https://www.iea.org/data-and-statistics/charts/quarterly-electric-car-sales-by-region-2021-2024>, Licence: CC BY 4.0.

31 Ibid., p. 26.

FIGURE 10. Clean technology manufacturing capacity by region [per cent, 2021]



Source: Internal analysis derived from: The future of European competitiveness. Part A. A competitiveness strategy for Europe, September 2024, p. 42.

In several areas of hydrogen economy, the EU maintains a competitive advantage, *e.g.*, in the construction of electrolyzers or CO₂ storage. However, it is often the case that while the idea is European, the place of manufacture is in China. This is due to lower labour costs and the availability of the raw materials needed. For example, around 40 raw materials are required to manufacture an electrolyzer, of which up to 5 per cent are currently available in Europe. The manufacturing capacity of clean technologies in 2021 by manufacturing region is shown in Figure 10.

Conclusions

Climate risk is a systemic risk that can be managed through coordinated global policy action. It requires a change in approach to the green economy, decarbonisation of the economy, and energy transition in most economies of the world, including in the EU beyond any doubt. Today, it is beyond dispute in most of the world that climate change exists. In fact, it is unquestionable. If the current trend continues, the damage caused by the effects of climate change (floods, fires, droughts, low surface water levels, snowstorms, and significant temperature differences) will have significant financial and economic implications.

Due to the existing threat, changes in the current economic system are needed and new economic ideas and methods need to be applied, such as the green economy and the circular economy. These two leading ideas make it possible to achieve the climate goal set by the countries of the world at the Paris Climate Conference, which is to limit the temperature increase to 1.5 °C by 2050. To achieve this goal, the decarbonisation of national economies is required. This is the impetus for the energy transition and the launch of innovation and business innovation processes.

With the energy transition and the ongoing decarbonisation process, a new paradigm for the energy system is now emerging. The system requires innovation and the use of new or modified energy, transport, and digital technologies. Moreover, companies at the national level need to be competitive with other market participants. Competitiveness during the process of decarbonisation and the development of the green economy and the circular economy will be possible only if one of the key production factors (energy and its carriers) is priced at an appropriate level. Appropriate price levels enable competition with economic players from other countries, such as China or the US. Otherwise, the EU, which does not have efficient and effective mechanisms in place to support the creation

and implementation of technological and digital breakthrough innovations, will gradually lose competitiveness. In the extreme case, this may result in an exodus of companies from EU Member States to countries that have lower production costs (mainly energy) and have no regulatory and legal barriers for operation and development.

The public and private sectors, including insurers as providers of risk transfer capacity, risk knowledge, and long-term investment, can facilitate transition to a low-carbon economy. Increasing transparency, data, and disclosure to price and transfer risks is needed. To this end, we should see more policy action on carbon pricing coupled with incentivising nature-based and carbon-offsetting solutions. International convergence on the taxonomy on counts for green and sustainable investments is also needed. As part of corporate reporting, institutions should also disclose their roadmaps on how they intend to reach the Paris and 2050 net-zero targets.³²

It is very likely that economy models based on the implementation of the green economy and the circular economy will fail to meet the targets of these economies as a result of current and future polycrises. In some economies, excessive targets that cannot be met within the time limit have been set. For example, the public administration in Scotland made a commitment in 2019 to achieve a 75 per cent reduction in greenhouse gas (GHG) emissions by 2030 compared to 1990 levels, but this target is now abandoned. Therefore, it seems that actions and processes are needed to revise the adopted targets, taking into account technological developments and the impact of current and potential polycrises on the selected economies and their targets relating to GHG reduction, the efficient use of available energy carriers, and the economically and environmentally efficient use of available natural and secondary resources.

Furthermore, as shown in this paper, most world economies identify similar problems that may occur in the future. However, the path to solving current and future problems is markedly different. Some economies, such as China or the USA, are leaders in specific areas of innovation and technology, including those related to the green economy. They create the right conditions for developing technology and obtaining funding. This is a special-purpose support that is not fragmented. This is how many countries in the world are building a new competitive position in the emerging global market for new clean technologies (solar panels, windmills, electric vehicles, batteries, and electrolyzers), developing technology

32 The economics of climate change: no action not an option, Swiss Re Institute, April 2021, p. 11.

demonstrators and creating or providing point-to-point support for key players in global markets, such as Tesla and BYD. This requires the creation of coordinated sectoral policies, the effects and objectives of which are constantly monitored and adapted to the current real and sustainable geopolitical and environmental conditions.

To date, the extent and limitations of the implementation of new technologies have been underestimated. It particularly refers to the fact that new monopolies, or oligopolies, with the natural and industrial resources to produce specific products, such as wind turbines and nacelles, photovoltaic panels, batteries for cars, and other electrical appliances, emerged on a global scale. No account has been taken of the rapid development of new information and communication technologies, particularly those based on AI, that lead to an exponential increase in the need for data centres, permanent and uninterrupted communication processes between data centres, and electricity supply. This makes it necessary to draw conclusions and develop principles (at global level) for limiting new electro-intensive technologies with high growth potential, *e.g.*, common AI tools that can be used for entertainment purposes in the case of the gradual enrichment of Asian and African populations.

The green economy and the circular economy require a constant search for technological, process, and product innovations and a readiness to implement breakthrough or even disruptive innovations. The need to search for new solutions should translate into increased investment in R&D activities. If the current leading economies of the world do not show determination and set realistic goals, they will be forced into rapid and negative economic change. By not participating in the development of new clean technologies, they automatically become uncompetitive.

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Comparisons of the monetary policy of the central banks of the Federal Reserve Bank and the European Central Bank, and the Central Bank of Poland

Dariusz Prokopowicz

Introduction

A comparative analysis of the monetary policies of central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), includes a comparison of their actions in the context of managing the economies of the United States and the eurozone. Although both central banks aim to stabilise economies and ensure financial stability, they differ in their approach to their tasks due to the specifics of their mandates and economic structures. The Fed, in line with its so-called “dual mandate”, seeks maximum employment and price stability, which makes its actions more flexible when it comes to tackling inflation and unemployment. The ECB, on the other hand, prioritises price stability, which stems from its overarching goal of keeping inflation close to, but below, 2 per cent. The ECB’s monetary policy is therefore more focused on price stability than on promoting employment and economic growth, which are more important to the Fed.

In terms of monetary policy tools, both banks use similar instruments, such as open market operations, interest rates, and reserve requirements. However, they differ in the way they use them. The Fed mainly manipulates the federal funds rate, which affects the cost of interbank borrowing, and actively uses open market operations, such as buying and selling government bonds. The ECB, on the other hand, while also using these tools, places more emphasis on refinancing operations and long-term lending programmes for banks, such as TLTRO. In addition, it has introduced innovative programmes, such as the Asset Repurchase Programme, to support the eurozone economy, especially in times of crisis¹.

In the context of responding to financial crises, during the 2008 crisis and the COVID-19 pandemic, the Fed used extraordinary measures, such as zero interest rate policy (ZIRP) and quantitative easing (QE). The ECB also introduced QE programs and kept interest rates low, but its responses were more cautious and delayed. The complexity of the fiscal situation in eurozone countries, such as Greece, Spain, and Portugal, has forced the ECB to intervene to stabilise the financial system.

The economic structures of the US and the eurozone differ significantly. The US economy is an integrated unit with high capital and labour mobility, which allows the Fed to intervene more quickly. The eurozone, on the other hand, is a monetary union made up of many countries with different economic structures, fiscal systems, and debt levels², forcing more measured action by the ECB. The economic structures of the US and the eurozone differ significantly. The US economy is an integrated unit with high capital and labour mobility, which allows the Fed to intervene more quickly. Communication with financial markets also differs between the two central banks. The Fed, as a major player in the global financial system, has a transparent communication policy, whose regular appearances are crucial to the markets³. The ECB, while also conducting transparent communication, has to take into account the diversity of the eurozone economies, which makes its decisions more complicated and less clear-cut.

In view of the above, a comparison of the Fed's and ECB's monetary policies reveals similarities, but also important differences due to the different nature

1 F.K. Langdana, *Macroeconomic Policy: Demystifying Monetary and Fiscal Policy*, Vol. 3rd edition, Springer International Publishing Switzerland 2016, pp. 47–48.

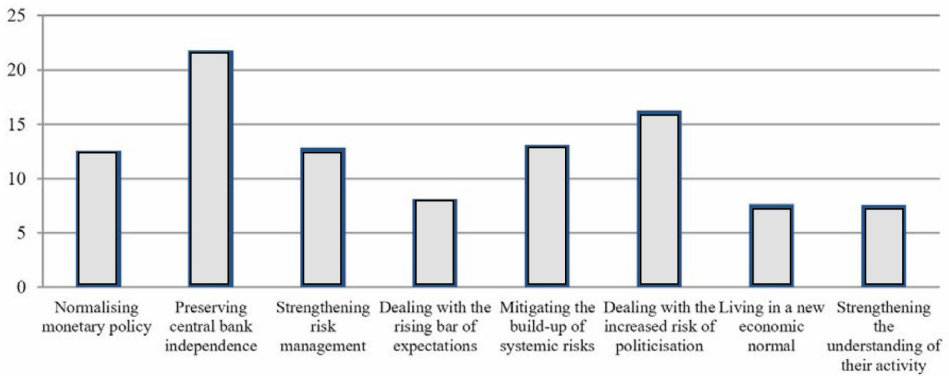
2 D. Millet, E. Touissant, *Kryzys zadłużenia i jak z niego wyjść*, Seria Biblioteka Le Monde Diplomatique, Publishing house Książka i Prasa, Warsaw 2012, pp. 27–28.

3 S. Hansen, M. McMahon, M. Tong, *The long-run information effect of central bank communication* (in: "Journal of Monetary Economics", 2019, No. 108, pp. 192–193).

of the economies the two central banks oversee. The FED has greater flexibility in its actions, while the ECB must tailor its policies to the needs of its many member countries with differing economic situations.

On the other hand, in terms of major implementation challenges, this is where there is a lot of synergy between the different central banks. The chart below shows that just before the Covid-19 pandemic, the central banks' main challenges included the following: preserving central bank independence, dealing with the increased risk of politicisation, mitigation the build-up of systemic risks, and strengthening and normalising monetary policy.

CHART 1. The main challenges for central banks in 2019



Source: N. Fraccaroli *et al.*, *Central Banks in Parliaments: A Text Analysis of the Parliamentary Hearings of the Bank of England, the European Central Bank and the Federal Reserve* (in:) "ECB Working Paper Series", European Central Bank, No. 2442 / July 2020, p. 40. A survey conducted in January 2019 among 30 central bank staff working on institutional matters in their respective central banks.

Note: the following central banks participated to the survey: Central Bank of Malta, Central Bank of Luxembourg, Reserve Bank of Australia, Bank of Mexico, Federal Reserve, European Central Bank, Bank of Ghana, Central Bank of Ireland, Bank of Estonia, Croatian National Bank, National Bank of Ukraine, Central Bank of Norway, Danmarks Nationalbank, Central Bank of Brazil, Swiss National Bank, Sveriges Riskbank, National Bank of Belgium, Bank of Portugal, Deutsche Bundesbank, Netherlands Bank, Central Bank of Cyprus, and Bank of England. Moreover, representatives of the IMF and FSB also participated in the survey.

7.1. Comparison of Fed and ECB monetary policies conducted in the context of the 2008 global financial crisis

Comparing the monetary policies of the Federal Reserve Bank (FED) and the European Central Bank (ECB) in the context of economic crises, particularly the 2008 global financial crisis⁴, is important for understanding the differences in the two central banks' approaches to stabilising their economies. Both institutions play a key role in stabilising markets, but their actions are driven by differences in mandates, the structure of their economies, and the characteristics of the markets they oversee⁵.

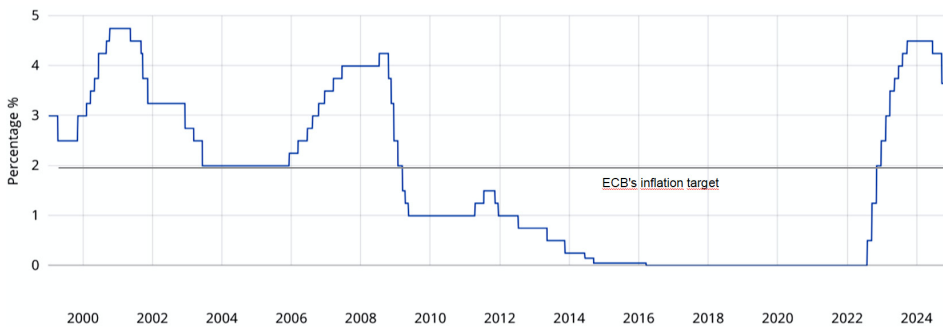
The 2008 financial crisis began in the United States as a result of a speculative bubble in the real estate market. The collapse of this market led to huge losses for financial institutions, bankruptcy of companies, and loss of investor confidence, which had a cascading effect on global markets. The eurozone, a key trading partner of the US, also suffered, requiring swift responses from the FED and ECB. The Fed's mandate includes two goals – maximising employment and maintaining stable prices. This has made its response to the crisis more dynamic, with an emphasis on a rapid return to economic growth. The ECB's mandate, on the other hand, focuses mainly on price stability, which meant that the ECB had to balance stabilising the economy with controlling inflation, resulting in a more cautious approach to the crisis.

The two central banks' responses to the crisis differed not only in the speed of action, but also in the tools used. The Fed quickly cut interest rates almost to zero and implemented an unprecedented quantitative easing (QE) programme. It also introduced bank support programmes, such as the Term Auction Facility, and swap lines with the ECB to provide liquidity to global financial markets. In turn, the ECB lowered interest rates in a more gradual manner, launched Long Term Refinancing Operations (LTRO) and Securities Markets Programme (SMP) programmes to stabilise sovereign debt markets in eurozone countries.

In the long term, the Fed's actions brought a rapid economic recovery but stirred controversy over rising wealth inequality. The ECB's actions, while stabilising

4 D. Prokopowicz, A. Dmowski, *Rynki finansowe*, Publishing House Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2010, pp. 316–317. ISBN 978-83-7641-330-3.

5 A. Boussalem, B. Azeddine, S. Abdessamed, *Monetary policy management and central banks Federal Reserve bank versus European Central bank*, (in:) „Review of Human Science”, Vol. 22, No. 1(2022), pp. 1605–1625.

CHART 2. ECB interest rates (Main refinancing operations).

Source: *Key ECB interest rates*, European Central Bank data (<https://data.ecb.europa.eu/main-figures/ecb-interest-rates-and-exchange-rates/key-ecb-interest-rates>), latest reading as of Nov. 4, 2024: 3.40 per cent.

the situation, were not enough to prevent a debt crisis in Europe, necessitating further measures in 2015–2018, such as full implementation of QE.

The basic parallels in the Fed's and ECB's actions were the use of quantitative easing (QE), interest rate cuts, interbank market interventions and international cooperation⁶. Both institutions introduced QE programmes, involving the purchase of assets, such as government bonds and mortgage-backed securities (MBS), to provide liquidity to financial markets. The Fed began its measures as early as 2008, while the ECB delayed similar steps until 2010. Both central banks cut interest rates significantly to stimulate economies and reduce borrowing costs – the FED quickly reduced rates to near zero, while the ECB took more cautious steps, reaching 1 per cent in 2009. Both the FED and ECB intervened in the interbank market, introducing liquidity programmes for banks, and coordinated internationally, including through swap operations.

The differences in the Fed's and ECB's actions are primarily due to differences in their mandates and the specifics of the problems they faced. The FED, with a broader mandate including both price stability and maximum employment, quickly implemented an extensive QE programme in 2008 to support the real

6 D. Szybowski, D. Prokopowicz, S. Gwoździewicz, *Activating interventionist monetary policy of the European Central Bank in the context of the security of the European Financial System* (in: "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 2 (4) 2016, pp. 139–140. ISSN 2450-2146.

economy, including the labour market and housing sector. The ECB, whose main objective was price stability, belatedly undertook full-scale QE measures, only in 2015, having previously focused on more restrictive programs, such as the Securities Markets Programme (SMP). In addition, the ECB faced specific problems in the eurozone, such as the debt crisis in southern European countries, which forced it to introduce programmes, such as the Outright Monetary Transactions (OMT), which pools the bonds of countries at risk of bankruptcy.

The Fed's key interventions included QE1, QE2, and QE3 programmes to support financial markets and the real economy, lowering interest rates to near zero, and supporting the real estate market through MBS purchases. The ECB, on the other hand, focused its efforts on stabilising the financial system, introducing SMP, OMT, and Long-Term Refinancing Operations (LTRO) programmes to provide liquidity to European banks, and Targeted Long-Term Refinancing Operations (TLTRO) to support lending.

The actions of both institutions, although different in scale and specifics, were aimed at countering the global financial crisis and limiting its negative effects, which ultimately stabilised global financial markets⁷. In the face of the global financial crisis in 2008, both the Federal Reserve (FED) and the European Central Bank (ECB) faced enormous monetary policy challenges. Their actions were crucial to stabilising the financial system and minimising the negative effects of the crisis⁸. Analysing the policies of these two institutions, one can see both parallels and differences in their approaches to monetary intervention.

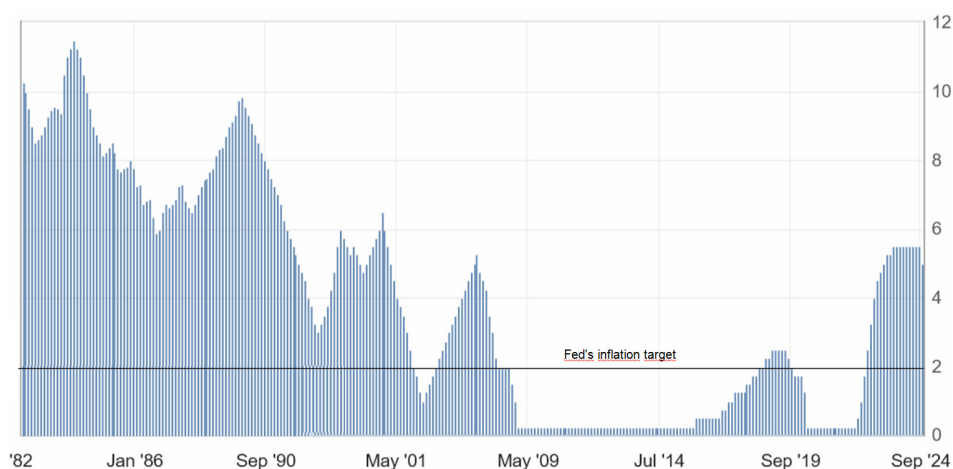
In response to the 2008 global financial crisis, both the Federal Reserve Bank and the European Central Bank used similar measures, although their responses differed in scale and timing. One of the main measures was quantitative easing (QE). The Fed introduced a QE programme as early as in 2008, focusing on buying government bonds and mortgage-backed securities (MBS) to increase liquidity in financial markets. The ECB, although it did not introduce full QE until 2015, had already implemented limited forms of QE in 2010 through bond purchases under its Securities Markets Programme (SMP), with the aim of stabilising markets affected by the eurozone debt crisis.

7 M. Matosek, D. Prokopowicz, J. Grzegorek, *Current and historical determinants of globalization processes* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji „Nauka-Edukacja-Rozwój”, No. 2 (8) 2018, Warsaw, December 2018, pp. 195–196. ISSN 2450-2146.

8 R. Nyman *et al.*, *News and narratives in the financial systems: exploiting big data for systemic risk assessment* (in:) "Bank of England working papers", No. 704, 2018, Bank of England.

Another significant action was the reduction of interest rates. The Fed lowered its rates to near zero (0–0.25 per cent) in December 2008 in an effort to support households and businesses. The ECB also cut interest rates, but the process was slower and more cautious due to inflation concerns. Both central banks also took action in the interbank market, offering liquidity to banks and organising repo operations to increase the availability of credit⁹ and stabilise the banking sector.

CHART 3. U.S. federal funds rate (in per cent, for the period between September 1983 and September 2024)



Source: *Fed Interest Rate Decision* (in:) financial portal "Investing.com", Markets, (<https://www.investing.com/economic-calendar/interest-rate-decision-168>), accessed 31.10.2024, after: Federal Reserve Bank data. (Last value: 5.00 per cent as of 18.09.2024).

International coordination was an important part of the response to the crisis. The Fed and ECB cooperated with other central banks to ensure the stability of the global financial system¹⁰. A key example of this cooperation was the swap operations that enabled the provision of US dollars to European banks,

⁹ A. Dmowski, J. Sarnowski, D. Prokopowicz, *Podstawy finansów i bankowości*, Wydawnictwo Centrum Doradztwa i Informacji Difin sp. z o.o., Warszawa 2005, pp. 253–254. ISBN 83-7251-552-2.

¹⁰ B. Domańska-Szaruga, *Common banking supervision within the financial safety net*, (in.) K. Raczkowski, F. Schneider, ed., *The Economic Security of Business Transactions. Management in business*, Publishing Chartridge Books Oxford, Oxford 2013, pp. 267–268. ISBN 9781909287686.

which increased liquidity during the crisis. However, despite many similarities in approach, the differences between the Fed's and ECB's actions were significant. First and foremost, the timing and extent of the introduction of QE differed. The Fed began QE as early as in 2008 and steadily increased the scale of this programme in subsequent years (QE2, QE3), with the aim of significantly expanding its balance sheet. The ECB, on the other hand, due to the eurozone debt crisis and concerns about fiscal stability, only implemented full QE in 2015. Another difference was the approach to price stability. The Fed's mandate included both price stability and maximum employment, which allowed the bank to focus on labour market support and economic growth¹¹. The ECB, on the other hand, focused mainly on price stability, leading to more cautious measures.

In addition, the Fed introduced programmes to support the real economy, including the purchase of mortgage-backed securities, with the aim of stabilising the US real estate market¹². The ECB has not implemented similar measures on such a scale due to its more conservative approach and structural differences between the US and eurozone economies. An important challenge for the ECB was the eurozone debt crisis, which forced the bank to implement specific programmes, such as the Outright Monetary Transactions (OMT), to support countries at risk of bankruptcy. Such fiscal challenges did not concern the Fed in the US context, where the fiscal system is more unified.

In view of the above, during the 2008 financial crisis, both the FED and the ECB undertook similar quantitative easing and interest rate cuts to stabilise their economies¹³. The differences in their responses were due to different mandates, the structure of their economies, and the timing of their intervention programmes. The Fed was more flexible and aggressive in its actions, while the ECB was more cautious and focused on price stability, which influenced its delayed introduction of unconventional measures¹⁴.

11 S. Jeanneau, *Financial stability objectives and arrangements – what's new? In Central bank governance and financial stability*. Bank for International Settlements 2011.

12 M. Schularick, A. M. Taylor, *Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870-2008* (in: "American Economic Review", 2012, No. 102(2), pp. 1045–1046.

13 D. Masciandaro, D. Romelli, *Ups and downs of central bank independence from the great inflation to the great recession: theory, institutions and empirics* (in: „Financial History Review”, 2015, No. 22(3), pp. 263–264.

14 A. K. Kashyap, C. Siebert, *Financial Stability Considerations and Monetary Policy* (in: „International Journal of Central Banking”, 2020, No. 16(1), pp. 247–248.

An analogy in the actions of the two central banks was the aggressive quantitative easing policy used in both cases, which aimed to restore liquidity to the markets and prevent the collapse of financial institutions. The differences were primarily in the banks' mandate –the Fed had a broader scope of action, allowing it to support the labour market and households in a more flexible manner, while the ECB had to adapt its actions to the more restrictive framework of inflationary stability and the differing fiscal situations of eurozone member countries.

In view of the above, the Fed and the ECB used similar tools, but their responses differed in scale and speed due to the different nature of their mandates and economic structures. In the face of future crises, the two central banks will likely need to work more closely together, given the increasing globalisation of markets and potential risks¹⁵.

The 2008 global financial crisis¹⁶ posed enormous challenges for the Federal Reserve Bank (FED) and the European Central Bank (ECB), forcing these institutions to take extraordinary intervention measures to prevent the collapse of the financial and economic system. The two central banks employed similar tools, but differed in the scale, timing of their interventions and priorities due to differences in the mandates and structures of the economies they managed.

7.2. Comparison of Fed and ECB monetary policies conducted in the context of pandemic economic crisis 2020

A comparative analysis of the monetary policies of the Federal Reserve Bank (FED) and the European Central Bank (ECB) in response to the 2020 COVID-19 pandemic economic crisis reveals differences in the two central banks' approaches to countering the deepening recession. Both central banks faced an unprecedented situation that required swift and decisive action to limit the negative impact of the pandemic on the US and eurozone economies.

15 S. Gwoździewicz, D. Prokopowicz, *Globalization and the process of the system and normative adaptation of the financial system in Poland to the European Union standards* (in:) *Globalization, the State and the Individual*, "International Scientific Journal", Free University of Varna "Chernorizets Hrabar", Chayka, Varna, Bułgaria 9007, Varna 2016, No. 1(9) 2016, pp. 67–68. ISSN 2367-4555.

16 D. Prokopowicz, A. Dmowski, *Rynki finansowe*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2010, pp. 316–317. ISBN 978-83-7641-330-3.

The COVID-19 pandemic, which erupted in 2020, brought global economic activity to an abrupt halt. Lockdowns, put in place to limit the spread of the virus, caused supply chains to collapse and consumer and investment demand to fall. The situation led to a surge in unemployment and deepened an economic crisis that proved to be the deepest since the Great Depression of the 1930s. The pandemic crisis, which was both a supply and demand crisis, forced central banks, such as the FED and ECB, to react quickly to stabilise markets and support the economies of their regions.

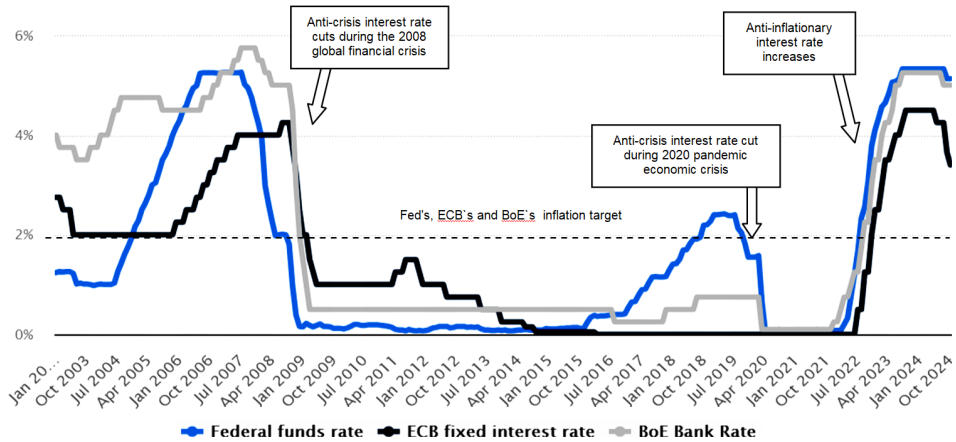
The US Federal Reserve's (FED) response has been swift and decisive, driven by its broad mandate including employment maximisation and price stability¹⁷. In response to the pandemic crisis, the Fed acted to lower borrowing costs by cutting interest rates to near zero and launching a massive quantitative easing (QE) programme. This programme included purchases of government bonds and mortgage-backed securities to support liquidity in the financial market and lower long-term interest rates. In addition, the Fed introduced repo programmes and credit support for businesses to mitigate the effects of pandemonium on companies and banks. These operations, supported by government programmes, were crucial to stabilising the US economy.

During the two decades of the current 21st century, *i.e.*, the period from 2003 to 2024, the central banks of the United States, the United Kingdom, and the European Union, in the face of a highly similar situation of changes in the economic growth rate of the domestic economy, applied analogous interest rate strategies. Analogous anti-crisis, anti-inflationary, etc. actions of central banks resulted in the strengthening of certain economic processes. At the beginning of the 21st century, immediately after the stock market crash recorded at the turn of the century mainly on the NASDAQ stock exchange, when then heavily discounted technological dot.com stocks interest rates were initially interventionist, anti-crisis low, and then were raised when economies re-entered a phase of over-credit of investment processes before 2008. Immediately before the onset of the 2008 global financial crisis, central banks proactively implemented significant interest rate cuts to near-zero levels as anti-crisis measures, which were then sustained for an extended period. During the first wave of the COVID-19 pandemic in the spring of 2020, central banks made successive interest rate cuts to historic lows, aimed

17 F. Smets, *Financial Stability and Monetary Policy: How Closely Interlinked?* (in:) „International Journal of Central Banking”, No. 10(2), 2014, pp. 278–279.

at interventionist anti-crisis recovery of the economic processes of plunging companies and businesses. The issue is illustrated in the chart below.

CHART 4. Monthly central bank interest rates in the US, EU, and the UK 2003–2024



Source: Internet portal "Statista.com", October 17, 2024 (<https://www.statista.com/statistics/1470953/monthly-fed-funds-ecb-boe-interest-rates>).

The European Central Bank (ECB), while operating in a more complex monetary union environment, also took a number of steps to counter the crisis. The ECB launched the Pandemic Emergency Purchase Programme (PEPP), which consisted of asset purchases to support liquidity in financial markets, particularly in the eurozone countries most affected by the pandemic. The ECB also continued its quantitative easing programme initiated in 2015 and expanded its Targeted Long-Term Refinancing Operations (TLTRO) programme to provide banks with low-cost financing and encourage them to lend to companies. The cooperation between the ECB and the Fed, which included swap lines, allowed European banks to access US dollar liquidity, which was key to stabilising financial markets in the region.

The responses of the FED and the ECB to the pandemic crisis were different. The Fed acted more aggressively, quickly cutting interest rates and expanding its quantitative easing programme on an unprecedented scale. It also worked closely with the government, offering a wide range of programmes to support businesses. The ECB, on the other hand, had to take into account the varying economic situations of eurozone member states, which limited its flexibility as compared

to the Fed. Nevertheless, the actions of both central banks were crucial to stabilising the economies in their respective regions¹⁸.

After the pandemic, both the FED and the ECB faced new challenges, such as rising inflation and the need to revise support strategies. In the US, rising inflation in 2021 and 2022 forced the Fed to tighten monetary policy by raising interest rates, which introduced the risk of an economic slowdown. Similarly, the ECB has had to respond to rising inflation in the eurozone, which has forced it to revise its existing support policies, taking into account the economic needs of individual member countries¹⁹.

Accordingly, the 2020 pandemic economic crisis forced central banks to use unconventional monetary policy tools to protect their economies from a prolonged recession. Both the Fed and the ECB have demonstrated flexibility and adaptability in the face of an unprecedented crisis, but differences in mandates and the structure of the US and eurozone economies²⁰ have influenced the diversity of strategies employed.

7.3. Dominant opinions and theories on the legitimacy and effectiveness of actions taken by the FED and ECB central banks in the context of financial and economic crises

Opinions on the legitimacy and effectiveness of actions taken by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), in the context of financial and economic crises, such as the 2008 global financial crisis and the 2020 pandemic crisis, are varied and often controversial. As a result, there are a variety of opinions, theories, and assessments regarding the actions of both institutions.

The effectiveness of the Fed's monetary policy is generally viewed in a positive light. The FED's actions in response to the 2008 financial crisis and

18 R.R. Bliss, G.G. Kaufman, *Financial Institutions and Markets. The Financial Crisis: An Early Retrospective*, Palgrave Macmillan Publishers Ltd., Houndmills, Basingstoke, Hampshire, New York 2010.

19 N. Fraccaroli *et al.*, *The evolution of the ECB's accountability practices during the crisis* (in:) "ECB Economic Bulletin", Issue 5, Article 1, European Central Bank, 2018.

20 A. Kwasek, D. Prokopowicz, *Determinanty wprowadzenia waluty euro w Polsce* (in:) "Kwartalnik Naukowy Uczelni Vistula. Vistula Scientific Quarterly", Akademia Finansów i Biznesu Vistula, No. 62 (5) 2018, September–October 2018, pp. 115–116. ISSN 2353-2688.

the COVID-19 pandemic, such as the introduction of zero interest rate policy (ZIRP) and quantitative easing (QE) programmes, have been viewed as crucial to stabilising the US economy. Proponents of these measures argue that they helped avoid a deeper recession and accelerated the economic recovery, as evidenced by rapid job growth and improving market conditions. In addition, the programmes have helped stabilise financial markets by improving credit availability. In contrast, opinions on the ECB are more mixed. Critics point out that the ECB's actions during the eurozone crisis were too cautious and delayed, resulting in longer periods of recession in some member countries. However, supporters of the ECB's policies point out that QE programmes and low interest rates were necessary to stabilise markets and support the eurozone recovery. In the context of the COVID-19 crisis, the introduction of the Asset Repurchase Programme (APP) and the decisions on TLTROs (Targeted Longer-Term Refinancing Operations) have received positive reviews as they were aimed at providing financial support to banks and households²¹.

Questions of the long-term effects of monetary policy are another area of concern. Critics are concerned that low interest rates and QE policies could lead to speculative bubbles in asset markets, as well as excessive debt. There are also concerns about possible inflationary effects, especially for the Fed, which has been struggling with rising inflation in recent years²². Both raise questions about the independence and transparency of central banks²³. Analyses point to the Fed's high degree of independence, which allows it to make decisions based on monetary rather than political objectives. This approach is often praised as crucial to the stability of the economy²⁴. In contrast, the ECB has to balance the different interests of eurozone member states, which leads to complex decisions and can undermine the perceived independence of the institution.

Both central banks tend to adapt their policies in response to changing economic conditions. In the case of the Fed, recent years have seen a greater focus

21 C. Langin, *The European Central Bank and the Federal Reserve System – a general comparison*, 2010. Retrieved: 14.10.2024, (<https://www.grin.com/en>).

22 J. Moroney, *Money Growth, Output Growth, and Inflation: Estimation of a Modern Quantity Theory* (in: "Southern Economic Journal", Southern Economic Association, Volume 69, No. 2/2002, pp. 398–413. (<https://doi.org/10.2307/1061679>).

23 C. Goodhart, R. M. Lastra, *Populism and central bank independence* (in: "Open Economies Review", 2017, No. 29(1), pp. 53–54.

24 K. Raczkowski, P. Komorowski (ed.), *Stabilność makroekonomiczna. Współczesne problemy podziału ryzyka*, Wydawnictwo Naukowe UKSW, Warsaw 2023, pp. 84–85. ISBN: 978-83-8281-236-7

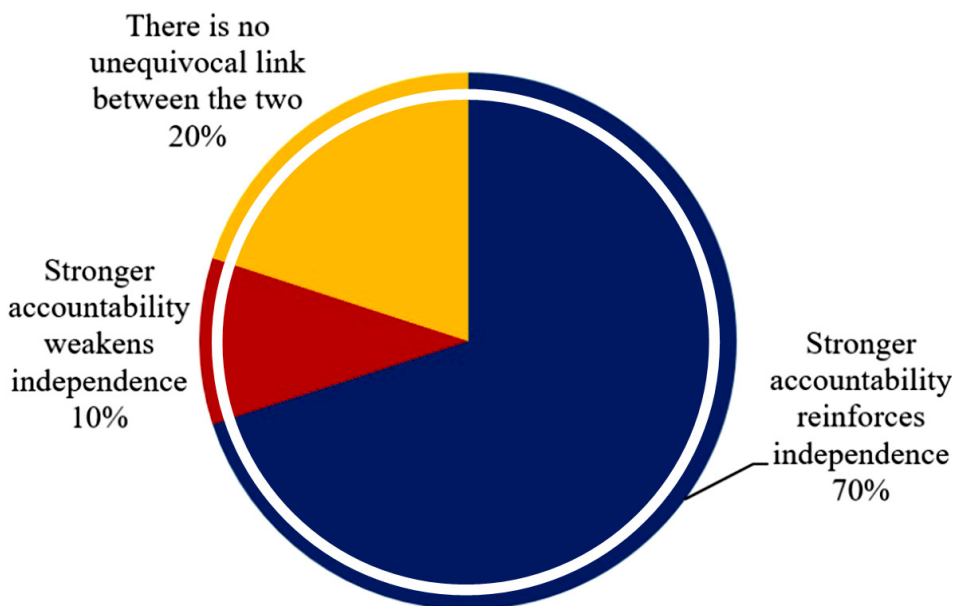
on social aspects, such as equality in access to credit. The ECB is also introducing new instruments, such as green bond rules, to strengthen its role in the context of sustainable development. Opinions on the Fed and ECB's actions are not without controversy. Criticism focuses on questions about the ethics and effectiveness of their actions in terms of the ultimate effects on national economies and financial markets. There are also doubts about the impact of monetary policy on socioeconomic inequality as it often benefits the more affluent classes of society who are more likely to invest in financial assets. The aforementioned actions taken by the Fed and ECB in response to financial and economic crises are the subject of mixed assessments. On the one hand, the effectiveness of both institutions' monetary policies is praised for their quick responses and support of the economy. On the other hand, concerns about long-term effects, independence, and the impact on socioeconomic inequality paint a complex picture of how these institutions operate in the face of changing economic conditions.

The Fed and ECB's actions in response to financial and economic crises have been the subject of much analysis and debate since the late 20th century. While both institutions have taken significant steps to stabilise economies, their approaches and the effects of these actions vary considerably depending on the economic and political context, keeping the discussions on the topic topical and complex²⁵. The chart below shows the relationship between central bank independence and accountability. The largest share, *i.e.*, 70 per cent was the following relationship: stronger accountability reinforces independence. The chart below shows the relationship between the independence of the central bank and the accountability of its monetary policy.

Note: the following central banks participated to the survey: Central Bank of Malta, Central Bank of Luxembourg, Reserve bank of Australia, Bank of Mexico, Federal Reserve, European Central Bank, Bank of Ghana, Central Bank of Ireland, Bank of Estonia, Croatian National Bank, National Bank of Ukraine, Central Bank of Norway, Danmarks Nationalbank, Central Bank of Brazil, Swiss National Bank, Sveriges Riskbank, National Bank of Belgium, Bank of Portugal, Deutsche Bundesbank, Netherlands Bank, Central Bank of Cyprus, and Bank of England. Moreover, representatives of the IMF and FSB also participated in the survey.

²⁵ W. Streeck, *Buying Time. The Delayed Crisis of Democratic Capitalism*, Publishing house Verso, London/New York 2014.

CHART 5. Relationship between the independence of the central bank and the accountability of its monetary policy



Source: N. Fraccaroli et al., *Central Banks in Parliaments: A Text Analysis of the Parliamentary Hearings of the Bank of England, the European Central Bank and the Federal Reserve* (in:) "ECB Working Paper Series", European Central Bank, No. 2442 / July 2020, p. 41. A survey conducted in January 2019 among 30 central bank staff working on institutional matters in their respective central banks.

7.4. Dominant opinions and theories on the legitimacy and effectiveness of actions taken by the central banks FED and ECB in the context of stabilising exchange rate movements

Opinions, theories, and assessments regarding interventionist measures taken by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), in the context of stabilising exchange rates in crisis situations are varied and reflect different economic and political perspectives²⁶. In the context of the effectiveness of currency interventions, views on the FED

²⁶ I. Klodiana, P. Anamaria, *Public Opinion on Central Banks when Economic Policy is Uncertain* (in:) „Working Paper”, No. 765, 2020, Banque de France.

tend to be positive. In particular, during the 2008 global financial crisis and the COVID-19 pandemic, the FED used a variety of tools, including quantitative easing policies, to influence the value of the US dollar and ensure financial stability. Proponents of these measures argue that these interventions helped maintain confidence in the US financial system and minimised the risk of destabilising international markets.

On the other hand, the ECB also took steps to stabilise the euro exchange rate, especially in the context of the eurozone crisis. The introduction of asset-purchase programmes and low interest rates were intended to support the value of the euro in the face of financial turmoil in some member countries. Nevertheless, critics point out that the ECB often acted late, and its interventions were too limited, which could lead to further depreciation of the euro in difficult times.

In the context of currency interventions, several economic theories are developing that attempt to explain the effectiveness of such measures. One dominant theory, the purchasing power parity theory, suggests that long-term changes in exchange rates should reflect differences in inflation between countries²⁷. As a result, interventions by central banks, such as the FED and ECB, can be seen as short-term solutions that do not always lead to longer-term rate stabilisation. Critics argue that such actions can lead to unpredictable consequences that can undermine confidence in monetary policy.

Another theory, signalling theory, focuses on the role of communications and signals sent by central banks²⁸. In the case of the Fed, regular and clear communications on monetary policy can influence market expectations, which in turn stabilises the dollar²⁹. The ECB also tries to communicate its intentions, but due to the diversity of member countries' interests, these signals can be less clear and effective³⁰.

27 N. Gumata, E. Ndou, *Revisiting the Role of the Money Demand Function: Does the Shortfall in Money Demand Impact the Inflation Responses to the Exchange Rate Depreciation Shocks?* (in:) "Achieving Price, Financial and Macro-Economic Stability in South Africa", May 2021, Cham: Palgrave Macmillan, pp. 427–442. (doi.org/10.1007/978-3-030-66340-7_28).

28 S. Hansen, M. McMahon, *Shocking language: Understanding the macroeconomic effects of central bank communication* (in:) "Journal of International Economics", 2016, No. 99, pp. 117–118. 38th Annual NBER International Seminar on Macroeconomics.

29 S. Merler, *Central banks in the age of populism*, Bruegel blog post, 19 March 2018.

30 E. Tobback *et al.*, *Between hawks and doves: measuring central bank communication* (in:) "ECB Working Paper", No. 2085, European Central Bank, 2017.

Criticism of the Fed's and ECB's actions focuses on several key areas. First, many believe that these interventions can lead to artificial stabilisation of rates, which in turn can distort markets and lead to unhealthy speculation. Second, some economists argue that prolonged interventions could undermine the long-term fundamentals of the economy, leading to increased debt and potential inflation problems.

The actions of the Fed and ECB also have a significant impact on global financial markets³¹. Strong monetary policy interventions in the US, especially during crises, can lead to a weakening of other countries' currencies, which affects the trade balance and creates tensions in international relations. On the other hand, the ECB's actions are aimed at protecting the eurozone, but their effects can also be felt in countries outside the monetary union.

In line with the above, opinions on the interventionist actions of the Fed and ECB in the context of exchange rate stabilisation are mixed. While many recognise the effectiveness of these actions in the short term, the long-term effects and risks of currency interventions are controversial. Theoretical approaches to analysing central bank actions point to the complexity and multifaceted nature of the problem, as well as the need to balance stabilisation efforts with long-term economic health. In future, it will be crucial to continue monitoring the effects of currency interventions and adjusting monetary policy to the dynamically changing economic environment.

7.5. Dominant opinions and theories on the legitimacy and effectiveness of the measures taken by the FED and ECB central banks in the context of quantitative easing

Opinions, theories, and assessments regarding the interventionist actions of central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), in the context of quantitative easing and increasing the amount of money in the economy in crisis situations, are varied and often controversial. Quantitative easing (QE) is seen by many economists as an effective tool in dealing with financial crises. Introduced by the Fed after the 2008 crisis and

³¹ M. Matosek et al., *Current and historical determinants of globalization processes* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji „Nauka-Edukacja-Rozwój”, No 2 (8) 2018, Warsaw, December 2018, pp. 196–197. ISSN 2450-2146.

by the ECB in response to the Eurozone crisis, QE programmes were designed to increase liquidity in the financial system, lower interest rates and stimulate the economy³². Proponents of these measures emphasise that QE helped prevent a deeper recession by increasing the availability of credit and supporting investment growth.

During the 2008 financial crisis³³, the Fed initiated several rounds of quantitative easing, which led to a significant drop in interest rates and an increase in the central bank's balance sheet. As a result, the US economy began to show signs of recovery, and indicators such as GDP and employment growth began to rise. Similarly, the ECB introduced QE programmes to counteract economic stagnation in the eurozone, which contributed to improvements in some member countries. Despite the positive effects, criticism of quantitative easing focuses on several key aspects. One of the main arguments of opponents is the fear of inflation. Critics argue that increasing the amount of money in the economy could lead to higher prices, which in turn could weaken consumers' purchasing power. After years of quantitative easing, inflation in the US in 2021 began to reach historic levels, raising questions about the effectiveness of the Fed's policy.

Another major argument concerns the impact of QE on wealth inequality. Critics point out that quantitative easing mainly supports financial markets, which leads to an increase in the value of assets, such as stocks or real estate, which in turn primarily benefits those who own these assets³⁴. As a result, it can lead to a widening of wealth disparities in society, raising questions about social justice. In the context of central bank intervention, several economic theories are developing that attempt to explain the effectiveness of such actions. Economists based on the efficiency theory of markets argue that actions such as QE can be largely predicted by financial markets, meaning that their impact on the economy may be limited. As a result, increasing the amount of money in circulation may not have the desired effect, and markets may react quickly to changes in monetary policy, which could limit the effectiveness of interventions.

32 L. Laeven, F. Valencia, *Systemic Banking Crises Database: An Update* (in:) "IMF Working Paper", 2012, No. 12(163).

33 P. Arestis, E. Karakitsos, *Subprime mortgage market and current financial crisis* (in:) P. Arestis, P. Moos-lechner, K. Wagner (Hrsg.), "Housing market challenges in Europe and the United States. Any solutions available", pp. 40–59. Palgrave Macmillan, New York 2009.

34 A. Neuhierl, M. Weber, *Monetary policy communication, policy slope, and the stock Market* (in:) "Journal of Monetary Economics", 2019, No. 108, pp. 147–148.

Another theory, the liquidity trap theory, indicates that in crisis situations, such as those of 2008 or the COVID-19 pandemic, the economy may find itself in a “liquidity trap” in which traditional monetary policy tools, such as interest rate cuts, become less effective. In such a context, quantitative easing becomes a necessary tool to stimulate demand and ensure financial stability. Ultimately, although the Fed and ECB interventions are aimed at stabilising the economy, their effectiveness and long-term consequences are still the subject of intense debate in the economic world.

Advocates of quantitative easing and monetary easing argue that in crisis situations, such as the 2008 global financial crisis³⁵ and the 2020 pandemic crisis, such measures were necessary to prevent a deepening recession and destabilisation of financial systems. It is argued that by injecting additional money into the economy and lowering interest rates, central banks increased liquidity in the markets, allowing businesses and consumers easier access to credit. In the short term, these policies have helped revive economies, limiting the decline in output, the rise in unemployment and the collapse of the financial sector. In addition, these measures strengthened asset markets, which boosted investor confidence and contributed to a faster capital market recovery.

However, critics point to the negative consequences of such a policy. One of the main problems associated with quantitative easing is the potential increase in inflation. Introducing significant amounts of new money into circulation can lead to an increase in demand, which, given limited economic resources, can generate inflationary pressures. This phenomenon was particularly evident after the pandemic crisis, when many economies struggled to cope with soaring prices linked to, among other things, disruptions in supply chains and rising costs of raw materials³⁶. The Fed and ECB are now facing the challenge of how to balance a return to tighter monetary policy to control inflation without causing a sharp economic slowdown.

35 D. Prokopowicz, A. Dmowski, *Rynki finansowe*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2010, pp. 316–317. ISBN 978-83-7641-330-3.

36 K. Golczak et al., *Prognoza globalnego kryzysu finansowo-gospodarczego zdeteminowanego przez pandemię koronawirusa w obszarze gospodarczym, społecznym, politycznym i geopolitycznym. Prognoza kryzysu w obszarze gospodarczym* (in:) P. Soroka et al. (ed.) *Raport zawierający diagnozę i prognozę globalnego kryzysu finansowo-gospodarczego zdeteminowanego przez pandemię koronawirusa w obszarze gospodarczym, społecznym, politycznym i geopolitycznym*, Publishing House Elipsa, Warsaw 2021, pp. 92–93. ISBN 978-83-8017-375-0.

In addition, some economists argue that quantitative easing contributes to speculative bubbles in asset markets, including real estate and stock markets. Cheap money and low interest rates can encourage excessive debt and investment in risky assets, which can lead to destabilisation of the financial system in the long term. There is also concern that quantitative easing policies are exacerbating wealth inequality, as asset owners benefit the most, while those with lower incomes may not experience direct benefits.

With regard to central banks, such as the ECB, operating in the eurozone, critics highlight the additional challenges of coordinating monetary policy amid differing member economies. Quantitative easing and low interest rates can benefit countries with high debt, such as Italy and Greece, but can also lead to over-stimulation of stronger economies, such as Germany, which can exacerbate differences among member states.

In view of the above, the Fed's and ECB's interventionist measures based on quantitative easing and monetary easing have been seen as an effective response to crises, but at the same time they raise numerous concerns about their long-term effects. Rising inflation, the risk of speculative bubbles and deepening wealth inequality are the main risks associated with these policies, which central banks must now take into account when formulating exit strategies for extraordinary monetary measures³⁷. Opinions on the legitimacy and effectiveness of the actions of central banks, such as the FED and ECB, in the context of quantitative easing are complex. On the one hand, many see the benefits of these measures in the short term, especially in the face of financial crises, pointing to economic improvements and increased investment. On the other hand, criticism focused on inflationary risks and social inequality shows that the long-term effects of these interventions may be problematic. The debate over the effectiveness and legitimacy of quantitative easing is still ongoing, and the future of monetary policy will require further analysis and adjustment of strategies to minimise risks and maximise benefits for economies and societies³⁸.

37 D. Szybowski et al., *Activating interventionist monetary policy of the European Central Bank in the context of the security of the European Financial System* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój w Warszawie, No. 2 (4) 2016, pp. 141–142. ISSN 2450-2146.

38 F. Torres, *The EMU's Legitimacy and the ECB as a Strategic Political Player in the Crisis Context* (in:) „Journal of European Integration”, 35(3), 2013, pp. 291–292.

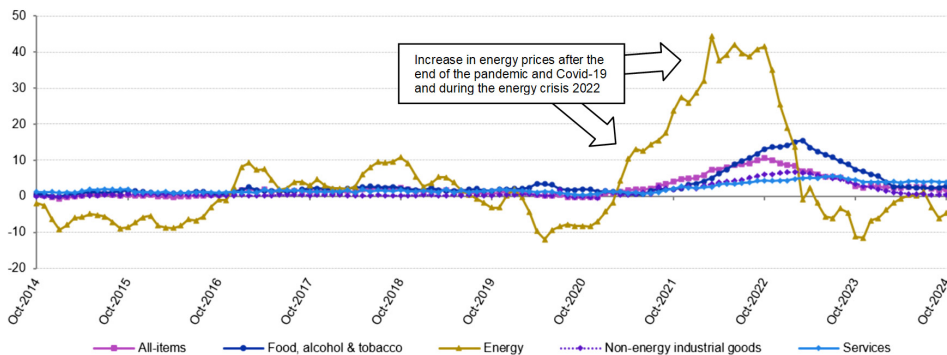
7.6. Dominant opinions and theories on the legitimacy and effectiveness of the FED and ECB central banks' monetary tightening efforts

Opinions and theories on the legitimacy and effectiveness of interventionist measures taken by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), in situations of monetary tightening vary, and assessments of the effects of these measures depend on the economic and political perspective adopted. Tightening monetary policy, especially by raising interest rates and restricting the money supply (*e.g.*, by reversing quantitative easing), aims to control inflation, stabilise the economy and prevent market overheating. However, these actions have potential negative consequences, which are widely discussed in both economic theory and practice.

Advocates of tightening monetary policy insist that it is a necessary tool to combat inflation, especially in situations where excessive growth in the money supply and low interest rates lead to higher prices for goods and services. In such cases, as in 2022, when inflation skyrocketed as a result of the COVID-19 pandemic³⁹ and the disruption of global supply chains, central banks find it necessary to take action to reduce inflationary pressures. From this perspective, raising interest rates helps curb excess demand, curbs consumption, and reduces the risk of sustained inflation. In addition, tightening monetary policy can also restore stability in financial markets, reducing the risk of speculative asset bubbles. The chart below shows the development of the level of annual inflation in the eurozone and its main components for the period from October 2014 to October 2024.

On the other hand, critics point out the many negative effects of tightening monetary policy, which could lead to a downturn or even recession. Rising interest rates increase the cost of borrowing, which negatively affects companies' ability to invest and expand their businesses, as well as consumers' ability to take out mortgages and consumer loans. This in turn leads to a decline in investment and consumption, which can cause a general downturn in the economy. In the long run, if monetary tightening is too aggressive, there could be a sharp economic slowdown, rising unemployment and a decline in living standards. Tightening

39 P. Komorowski, D. Prokopowicz, *Impact of the coronavirus pandemic (Covid-19) on financial markets and the economy* (in:) "International Journal of Legal Studies", Międzynarodowy Instytut Innowacji „Nauka – Edukacja – Rozwój”, Warsaw, December 2021, Volume 10, No. 2 (10) 2021, pp. 91–92. DOI: 10.5281/zenodo.5851358. ISSN 2543-7097.

CHART 6. Euro area annual inflation and its main components, October 2014 – October 2024 (estimated)

Source: Eurostat, 31 October 2024.

of monetary policy by the Fed and ECB has also been criticised for possible negative consequences for financial markets⁴⁰. Higher interest rates lead to a reduction in the market value of bonds and an increase in the cost of servicing public and private debt, which can cause turbulence in capital markets. When companies and countries are heavily indebted, interest rate hikes can significantly increase the risk of default, especially in countries with weaker financial fundamentals, as it happened in the eurozone during the 2010–2012 debt crisis.

An additional problem may be the effect of monetary “lags”, *i.e.*, delays in the effects of policy decisions made. Central bank actions, such as raising interest rates, often have a delayed effect on the real economy. This can lead to a situation where the economy is already in a downturn, and the effects of the actions taken are only becoming felt, deepening the crisis.

From the point of view of the ECB’s monetary policy, the situation is further complicated by the diversity of eurozone member economies. Countries with high debt levels, such as Italy and Greece, may be particularly vulnerable to the negative effects of monetary tightening, as higher public debt servicing costs can lead to fiscal difficulties. In contrast, countries with stronger economic fundamentals, like Germany, are likely to be better positioned to withstand a period of monetary

40 D. Filip, P. Komorowski, *Konkurencyjność rynków finansowych. Czynniki efektywności* (in:) “Przedsiębiorstwo & Finanse”, No. 2/2016 (13), Białystok 2016, pp. 67–68.

tightening. This leads to the risk of widening divergences among member countries, which poses an additional challenge for the ECB in maintaining a uniform policy for the entire eurozone.

In view of the above, the tightening of monetary policy by central banks, such as the Fed and the ECB, is aimed at controlling inflation and stabilising the economy, but carries the risk of slowing economic growth, reducing investment, increasing unemployment, and destabilising financial markets. The effectiveness of these measures depends on the skilful balancing of policies so as not to exacerbate the downturn too much. At the same time, a key challenge remains the adaptation of policies to the specific conditions of individual economies, especially in the context of the Eurozone's diverse economic structures.

7.7. Dominant opinions and theories on the key macroeconomic factors that are taken into account, factored into the formation of monetary policy, and are the basis for certain interventionist actions taken by the FED and ECB central banks

In evaluating the monetary policies of central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), certain macroeconomic factors are crucial. These factors include, among others, the level of inflation, unemployment rates, the rate of economic growth, the condition of the financial sector, the level of public and private debt, and the situation in international markets. Central banks, analysing these indicators, try to adjust their policies in such a way as to balance macroeconomic stability with the need to promote economic growth, while reducing the risk of financial crises⁴¹.

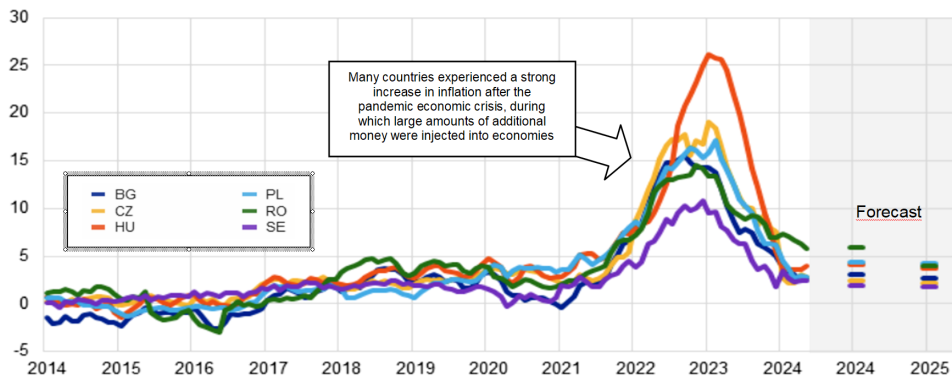
One of the fundamental monetary policy goals of both the FED and the ECB is to keep inflation stable. The ECB particularly emphasises its commitment to keeping inflation “close to, but below, 2 per cent” over the medium term, while for the Fed the goal is “price stability”, which also translates into similar actions on inflation control. It is worth noting that in moments of crisis, such as the 2008 global financial crisis and the 2020 COVID-19 pandemic, central banks used

⁴¹ J. Komorowski, P. Komorowski, *International financial system versus economic stability*, (in:) K. Raczkowski, P. Komorowski (ed.), *International Economic Policy for the Polycrisis*, Routledge, London 2025, pp. 118-119.

quantitative easing (QE) policies to counter deflation and stimulate economic growth by increasing the money supply in the economy.

The chart below shows the evolution of HICP inflation over the long term and its projections (annual percentage changes) in selected 6 EU countries. The graph shows the strong increase in inflation in many countries that occurred after the Covid-19 pandemic. As a result, central banks raised interest rates, which caused a downturn in economies while commercial bank profits increased, which occurred in many countries where the increase in inflation was exceptionally large and central banks strongly tightened monetary policy anti-inflationary by raising interest rates.

CHART 7. Formation of HICP inflation in the long term and its forecasts (annual percentage changes) in selected 6 EU countries



Sources: *Convergence Report*, European Central Bank, June 2024 (<https://www.ecb.europa.eu/press/other-publications/convergence/html/ecb.cr202406-475c2172bc.pl.html>) after: Eurostat, European Commission (Directorate General for Economic and Financial Affairs) and European Central Bank.

Note: Solid lines show annual percentage changes in monthly HICP inflation. Shaded area shows projections for annualised HICP inflation from the European Commission's Spring 2024 economic forecast.

The manipulation of interest rates is the primary tool of central banks to influence borrowing costs, investment, and consumption. In business cycles, central banks lower interest rates to stimulate the economy, especially during recessions. Since the 1990s, we have seen cyclical changes in interest rates in response to various crises characterised by severe economic downturns: the Asian crisis (1997–1998), the dotcom tech bubble (2000), the global subprime financial crisis

(2007–2008), and then the pandemic economic crisis (2020). Interest rate cuts are often combined with quantitative easing policies, further increasing liquidity in financial markets⁴². Besides, according to some researchers, business cycles, the specific interventionist fiscal and monetary policy instruments used during them, can also be correlated with political cycles, which also tend to be executed over a period of several years⁴³.

Both the FED and the ECB monitor the level of unemployment and the rate of economic growth, trying to keep these indicators at levels close to potential gross domestic product (GDP). In the US, the Fed's policy is based on a so-called dual mandate, which includes both price stability and maximum employment. In practice, this means that the Fed is more flexible in taking action to support employment growth during periods of economic downturn, such as after the 2008 global financial crisis. The ECB, operating in an area with diverse economic structures, has to take into account different levels of unemployment in member countries, which complicates its operations. Nevertheless, both central banks use similar response models – interest rate cuts and quantitative easing to revive the economy. Both institutions play a key role in stabilising the financial sector, especially during periods of financial crises. In 2008–2009, during the global financial crisis, both institutions implemented extensive rescue programmes for banks and financial institutions⁴⁴. The Fed, through its TARP (Troubled Asset Relief Programme) and QE programmes, significantly increased liquidity in the financial sector, rescuing failing institutions. The ECB, in turn, supported banks in the eurozone by providing cheap financing on a large scale, such as through LTRO (Long-Term Refinancing Operations) programmes, especially for those threatened by the sovereign debt crisis.

42 B. Domańska-Szaruga, D. Prokopowicz, *Makroekonomiczne zarządzanie antykryzysowe* (in:) 34 Zeszyty Naukowe Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach, nr 107, Seria: Administracja i Zarządzanie (34) 2015, Uniwersytet Przyrodniczo-Humanistyczny, Wydział Nauk Ekonomicznych i Prawnych, Siedlce 2015, pp. 38–39. ISSN 2082-5501.

43 W. D. Nordhaus, *The political business cycle* (in:) "The Review of Economic Studies", 1975, No. 42(2), pp. 173–174.

44 D. Prokopowicz, *Synergy of post-2008 Anti-Crisis Policy of the Mild Monetary Policy of the Federal Reserve Bank and the European Central Bank* (in:) "International Journal of Small and Medium Enterprises and Business Sustainability", volume 4, No. 3, November 2019, Center for Industry, SME and Business Competition Study, Faculty of Economics, Trisakti University in Jakarta, Indonesia. University of Social Sciences, Warsaw, Poland, pp. 84-85. eISSN: 2442-9368.

An important aspect of monitoring monetary policy is the level of public and private debt. Excessive debt can lead to financial crises, as shown by the ECB's experience in 2010–2012, when it had to intervene to support the economies of Greece, Italy, or Spain, which prevented the breakup of the eurozone. In the US, by contrast, high public and private debt after the 2008 crisis and during the COVID-19 pandemic prompted the Fed to pursue an easing monetary policy to ease debt service through low interest rates.

Observing the actions of the Fed and the ECB over several decades, one can see cyclical patterns of response to economic changes. During periods of recession or slowdown, both central banks apply monetary easing, lowering interest rates, and introducing quantitative easing. In periods of economic expansion, on the other hand, there is a gradual tightening of monetary policy, including raising interest rates to control inflation and prevent the economy from overheating⁴⁵. These model relationships repeat themselves cyclically, as can be seen in the response to financial crises, such as the 2008 crisis and the 2020 pandemic crisis.

In view of the above, the interventionist actions carried out by the Fed and the ECB are based on common macroeconomic factors, such as inflation, unemployment, economic growth, and the health of the financial sector⁴⁶. Although the two institutions have different mandates and operate in different economic environments, their monetary policies show similar cyclical patterns of adjustment to changing conditions. It is worth noting, however, that each of these central banks operates in a specific context – the Fed has greater flexibility to adapt policy to domestic conditions, while the ECB must take into account the interests of a diverse eurozone.

45 K. Lutz, Z. Xiaoqing, *The Impact of Rising Oil Prices on U.S. Inflation and Inflation Expectations in 2020-23*, FRB of Dallas Working Paper No. 2116, November 2021, (<http://dx.doi.org/10.24149/wp2116>).

46 E. Thalassinou, *Trade Regionalization, Exchange Rate Policies and EU-US Economic Cooperation* (in: "European Research Studies", Volume X, Issue 1-2, 2007).

7.8. Key differences and determinants in the monetary policies used by the FED and ECB central banks

Although both the Federal Reserve Bank (FED) and the European Central Bank (ECB) pursue monetary policies based on similar principles⁴⁷, such as price stability and support for economic growth, there are key differences in their approaches due to their different mandates, economic structures, and the specific challenges they face⁴⁸.

One of the main differences between the two institutions is the mandate and objectives of monetary policy. The Fed operates under what is known as a “dual mandate”, meaning that its main goal is not only to maintain price stability, but also to maximise employment as much as possible. This gives the Fed greater flexibility in responding to economic changes as it can simultaneously seek to support the labour market and stabilise the economy. The ECB, on the other hand, has a more limited mandate, focused primarily on price stability, defined as keeping inflation “close to, but below, 2 per cent”. Only secondarily, once the inflation target is met, can the ECB seek to support economic growth and employment.

In addition, the diversity of the economies in which these central banks operate has a significant impact on their decision-making. The ECB operates in the euro-zone, which consists of 20 countries with diverse economic structures and levels of development. As a result, it must make decisions that are appropriate for the currency bloc, which sometimes leads to divergent interests among member states. For example, Germany often advocates a more restrictive monetary policy, while countries such as Greece and Italy prefer a more benign and growth-friendly approach. In contrast, the Fed manages monetary policy in a homogeneous economy, which simplifies decision-making tailored to a homogeneous market.

In terms of quantitative easing (QE), there are also differences in the two banks’ approaches. Although QE was a key tool for both institutions after the 2008 global financial crisis, the FED began its QE programme more quickly and on a larger

47 D. Prokopowicz, *Synergy of post-2008 Anti-Crisis Policy of the Mild Monetary Policy of the Federal Reserve Bank and the European Central Bank* (in:) “International Journal of Small and Medium Enterprises and Business Sustainability”, Vol. 4, No. 3, November 2019, Center for Industry, SME and Business Competition Study, Faculty of Economics, Trisakti University in Jakarta, Indonesia. University of Social Sciences, Warsaw, Poland, pp. 87–88. eISSN: 2442-9368.

48 S. Haggard, S. B. Webb, *What Do We Know About The Political Economy Of Economic Policy Reform?* (in:) “World Bank Research Observation”, No. 8 (2), 1993, pp. 143–168.

scale than the ECB. This reflects the Fed's more flexible approach to monetary policy. The ECB resisted the massive introduction of QE for longer, mainly due to opposition from northern European countries that feared inflation and inappropriate discipline of highly indebted countries. It was only in 2015–2016 that the ECB introduced a larger-scale asset purchase programme to counter deflation and stagnation in the eurozone.

Another aspect is the differences in interest rate policy. The ECB kept interest rates very low and even negative for an extended period, in response to prolonged economic stagnation and the risk of deflation in the eurozone. In contrast, the Fed raised interest rates more rapidly as the US economy began to recover from the recession following the financial crisis. The ECB's negative interest rate policy has been controversial and less common in the Fed's policies, where fears of sustained deflation have been less pressing.

Non-standard instruments and regulation are another area of difference. The Fed, as the central bank of the world's largest economy, has a wide range of non-standard stabilisation tools at its disposal, such as repo market operations and private sector bailout programmes. The ECB, on the other hand, must operate within the framework of European treaties, which limits its flexibility, forcing it to use more indirect measures, such as sovereign bond-buying programmes in the secondary market.

The two institutions' responses to economic crises also differ. In the wake of the 2008 financial crisis, the Fed quickly cut interest rates and introduced QE, taking a series of measures to stabilise the financial system. The ECB acted more cautiously, reacting later and introducing quantitative easing more slowly. The COVID-19 pandemic was another test for both institutions, where the Fed reacted quickly, introducing corporate rescue programmes, while the ECB had to take into account the conflicting interests of member states.

These differences are rooted in different economic structures, institutional mandates, and political and legal constraints. The Fed, operating in a unified US fiscal system, has more freedom in monetary and financial decision-making. The ECB, operating in a complex, multi-country structure, must take into account the diversity of economies and political priorities in the eurozone, which slows decision-making and limits monetary policy tools. In view of the above, while the two central banks' monetary policies are based on similar principles and tools, the differences in flexibility, scale, and speed of response are primarily due to the different mandates and economic and political conditions they face.

7.9. Key normative determinants of the differences between the Fed's and ECB's monetary policies

The legal norms that govern central banks, such as the Federal Reserve Bank (FED) in the United States and the European Central Bank (ECB) in the Eurozone, have both similarities and important differences that affect the formulation of their monetary policies. These differences are primarily the result of different legal mandates, historical traditions and the specific economic conditions in which these institutions operate.

The primary similarities between the Fed and the ECB include the pursuit of price stability. Both central banks have an obligation to counter excessive inflation, which is the main objective of their monetary policies. In addition, both the FED and the ECB have monetary policies that aim to control the money supply, interest rates, and liquidity in the market to stabilise economies and counter financial crises.

Important differences arise from the different mandates of the two institutions. The Fed's activities are based on the so-called "dual mandate", as defined in the Federal Reserve Act, which includes maximising employment and price stability. Unlike the ECB, the FED has greater flexibility in balancing these objectives, allowing it to take tailored actions in response to changing economic conditions. The ECB's mandate is more restrictive, in line with the Treaty on the Functioning of the European Union, which focuses on maintaining price stability, meaning inflation "close to, but below, 2 per cent". Growth and employment targets are treated as secondary, limiting the ECB's flexibility, especially in the face of rising unemployment.

The governance structure and decision-making framework also differ between the two institutions. The Federal Reserve System consists of 12 regional reserve banks, which have some autonomy, and monetary policy decisions are made by the Federal Open Market Committee (FOMC)⁴⁹. This allows the Fed to take into account specific economic conditions in different regions of the US. The ECB, on the other hand, operates within the eurosystem, which includes the ECB and the national central banks of the eurozone countries. Decisions are made

⁴⁹ D. Lucca, F. Trebbi, *Measuring central bank communication: an automated approach with application to FOMC statements* (in: „NBER Working Paper”, No. 15367, 2009, NBER).

by the Governing Council, which introduces the need to act for the entire eurozone, which often leads to difficulties in making uniform monetary decisions.

In terms of fiscal policy, the Fed operates within the framework of the unified US fiscal system, which allows for rapid and coordinated responses to economic crises. The ECB, on the other hand, operates in the eurozone, where each member country has an independent fiscal policy, which complicates the coordination of fiscal and monetary actions. EU treaties prohibit the ECB from directly financing governments, which limits its ability to support countries in economic distress.

These differences also translate into the approach to monetary policy tools. The Fed, given its more flexible mandate, can quickly implement non-standard tools, such as quantitative easing (QE) and repo operations to support financial markets. In contrast, the ECB operates within a more restrictive regulatory framework, which limits its flexibility to use non-standard tools. The ECB has long resisted the introduction of quantitative easing due to concerns from countries such as Germany about possible inflationary effects.

Ultimately, the differences in monetary policy making also stem from regulation. The Fed, with its dual mandate, can balance more effectively between inflationary goals and supporting the economy. In crisis situations, such as the 2008 global financial crisis and the COVID-19 pandemic, the Fed quickly lowered interest rates and launched stimulus programmes and quantitative easing. In contrast, the ECB, with a tighter mandate, maintained a conservative policy for a long time, which slowed its response to crises. In addition, the lack of a unified fiscal policy in the eurozone is a major constraint for the ECB, which must make decisions that benefit the entire eurozone⁵⁰, often leading to compromises, while the FED can better coordinate its actions with government policy, which increases the effectiveness of its interventions during crises. Accordingly, despite some similarities in monetary policy goals and tools, the legal norms governing the Fed and ECB result in significant differences in their approaches to monetary policy. The ECB's mandate, focused on price stability, and the lack of a unified fiscal policy in the eurozone, limit the flexibility of this central bank compared to the Fed.

50 A. Kwasek, D. Prokopowicz, *Determinanty wprowadzenia waluty euro w Polsce* (in:) "Kwartalnik Naukowy Uczelni Vistula. Vistula Scientific Quarterly", Akademia Finansów i Biznesu Vistula, No. 62 (5) 2018, September–October 2018, pp. 117–118. ISSN 2353-2688.

7.10. Macroeconomic characteristics differentiating the US and EU economies determining the differences in the monetary policies shaped by the FED and ECB central banks

Macroeconomic differences between the US economy and that of the European Union, including the eurozone, have a significant impact on the formulation of monetary policies implemented by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB). These differences determine how the two institutions make decisions on interest rates, money supply, quantitative easing (QE), and other monetary policy tools. There are several key economic specifics that influence these differences.

The first important factor is the structure of the economies. The US economy is characterised by a higher degree of centralisation and a unified fiscal system, which means that the federal government has full control over fiscal policy. This allows fiscal policy to be quickly coordinated with the Fed's monetary policy. In contrast, the eurozone is more complex, consisting of 20 different countries, making the lack of a common fiscal policy difficult for the ECB to coordinate with national budgets. In addition, eurozone countries differ in their level of economic development, leading to different monetary policy effects on each economy.

Another factor is economic growth rates. The US economy typically has a higher growth rate than the eurozone economy. Faster growth allows the Fed to pursue a more flexible monetary policy, including actively raising interest rates to control inflation, without worrying about an excessive slowdown in the economy. In contrast, the eurozone economy is growing more slowly, prompting the ECB to adopt a softer monetary policy to support growth and stimulate domestic demand⁵¹.

Labor markets and unemployment levels also differ in the two economies. The US labour market is more flexible, which translates into lower unemployment levels as compared to Europe. This allows the Fed to be more aggressive in raising interest rates in the context of a strong labour market. In contrast, in the eurozone, where unemployment, especially in the southern countries, is higher, the ECB needs to pursue a more cautious monetary policy so as not to increase unemployment.

⁵¹ D. Prokopowicz, *Synergy of post-2008 Anti-Crisis Policy of the Mild Monetary Policy of the Federal Reserve Bank and the European Central Bank* (in: "International Journal of Small and Medium Enterprises and Business Sustainability", Vol. 4, No. 3, November 2019, Center for Industry, SME and Business Competition Study, Faculty of Economics, Trisakti University in Jakarta, Indonesia. University of Social Sciences, Warsaw, Poland, pp. 86–87. eISSN: 2442-9368.

Inflation and price structure also differ between these economies. In the US, inflation tends to be more related to domestic factors, causing the Fed to react quickly with interest rate hikes when inflation rises. In the eurozone, on the other hand, inflation is more diverse and often driven by external factors, making it necessary for the ECB to pursue a more balanced inflation policy, taking into account global factors⁵².

Financial markets and the structure of the banking system also influence the monetary policies of both banks. The US has more developed capital markets, which means that the Fed's policies have a strong effect on the real economy. In the eurozone, where economies are more dependent on traditional banking systems, the ECB has a greater influence on the banking sector.

In terms of fiscal policy, the United States has a unified policy, which makes it easier to coordinate with monetary policy, while in the eurozone the lack of a central fiscal policy limits the ECB's ability to respond to crises. Finally, demographic differences are also important. The US economy has more favourable demographics, which encourages growth, while in Europe, an aging population puts pressure on the ECB to pursue a more accommodative monetary policy.

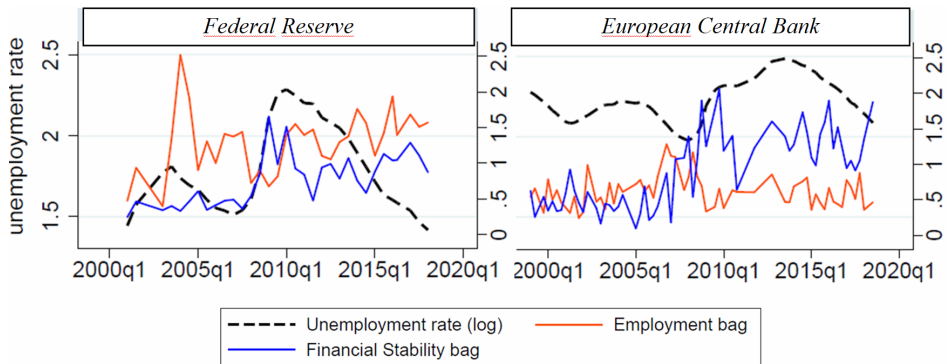
The macroeconomic differences between the US and the European Union shown above have a key impact on the monetary policies pursued by the Fed and the ECB. Each of these central banks must adapt their strategies to specific economic, structural, and demographic conditions, which influences their decisions. In view of the above, the US and eurozone economies have significant macroeconomic differences that determine the differences in monetary policies pursued by the FED and ECB. Prominent among the most important factors are the structure of the economies, the level of economic growth, labour markets, inflation, fiscal policy, and dependence on exports. The US, with a more flexible labour market, unified fiscal policy, and higher growth rates, allows the Fed to be more aggressive in its monetary policy⁵³. The eurozone, with greater political and economic complexity and slower growth, pursues a more cautious monetary policy, taking into account the different needs of its members.

52 M. Matosek et al., *Current and historical determinants of globalization processes* (in:) „International Journal of New Economics and Social Sciences”, Międzynarodowy Instytut Innowacji „Nauka-Edukacja-Rozwój”, No 2 (8) 2018, Warsaw, December 2018, pp. 197–198. ISSN 2450-2146.

53 M. De Pooter, G. Favara, M. Modugno, J. Wu, *Monetary Policy Uncertainty and Monetary Policy Surprises* (in:) “Discussion paper”, 2020-032, Federal Reserve Board, 2020.

The chart below shows the change in unemployment, employment, and financial stability issues for the two comparison central banks: Federal Reserve Bank and European Central Bank for the period of almost two decades ending just before the onset of pandemic Covid-19.

CHART 8. Unemployment growth and focus on employment and financial stability, by central bank



Source: N. Fraccaroli *et al.*, *Central Banks in Parliaments: A Text Analysis of the Parliamentary Hearings of the Bank of England, the European Central Bank and the Federal Reserve* (in: "ECB Working Paper Series", European Central Bank, No. 2442 / July 2020, p. 48).

7.11. The Anglo-Saxon model of the financial system and the European model of the financial system vs. monetary policy making by the central banks FED and ECB

The United States and the European Union have two distinct models of financial systems: the Anglo-Saxon and the European, which differ in many aspects. These differences have a significant impact on both the functioning of financial markets and on the formulation of monetary policy by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB). As a result of the different needs of the financial and economic sectors in the two regions, approaches to economic management also differ.

In the Anglo-Saxon model of the financial system, capital markets dominate. In the US, companies are more likely to raise capital by issuing securities, such as

stocks and bonds. Capital markets play a key role in capital allocation, and investment in stocks is common among both companies and households. There are also specialised banks, such as Goldman Sachs and Morgan Stanley, which focus on financial advice, securities issuance, and asset management. It is worth noting that while deposit and loan banks still play an important role, companies are more likely to use bond or stock issues than traditional bank loans.

In contrast, the European financial system model is based on universal banks, which provide a wide range of services— from deposits and loans to investment services. Banks, such as Deutsche Bank and BNP Paribas, offer a full spectrum of financial services. In Europe, companies are more likely to raise capital through traditional bank loans⁵⁴, which means that the stability of the banking sector is crucial to the entire financial system. Compared to the US, European capital markets are less developed, making their role in the economy limited.

These differences in the structure of the financial systems also affect the monetary policies of the two central banks. In the Anglo-Saxon model, capital markets dominate, making it necessary for the FED to monitor their condition to avoid destabilising the economy. Changes in interest rates by the FED have a direct impact on the cost of financing in the capital markets. For example, during periods of interest rate cuts, such as after the 2008 financial crisis, the FED had to take into account the risk of excessive increases in stock prices, which could lead to an asset bubble.

In contrast, in the European model, the ECB needs to focus more on stabilising the banking sector. Interest rate decisions should take into account the impact on banks' ability to lend. A rise in interest rates in Europe could lead to a reduction in the availability of credit for businesses, making it challenging for the ECB to maintain a balance between controlling inflation and supporting bank lending activity. In addition, differences in financial models affect the two central banks' responses to financial crises. The 2008 financial crisis in the US was caused by instability in capital markets, prompting the Fed to cut interest rates to near zero and introduce bond-buying programs. In Europe, on the other hand, the banking crisis was due to debt problems in some member countries, which

54 M. Hryniewicka, A. Trzaskowska-Dmoch, *Venture capital and banks loans as a combination of traditional and modern instruments for the financing of corporate Innovativeness*, (in:) "Zarządzanie w XXI w. Menedżer innowacyjnej organizacji", E. Gołębiewska (ed), "Przedsiębiorczość i Zarządzanie", Volume XIV, Tom 12, part of I, SAN, Łódź 2013, pp. 317–318. ISSN:1733-2486.

forced the ECB to intervene in the banking sector through loans to banks and liquidity support programmes⁵⁵.

In addition, attention should be paid to the impact of monetary policy on asset inflation. In the US, the Fed needs to respond more often to asset inflation because it has a greater impact on the economy, while the ECB can focus on traditional consumer inflation. As the most developed in the world, the US financial markets have a huge impact on the global economy. The Fed's monetary policy decisions are watched by investors around the world, which means that the Fed must also consider the international implications of its decisions. In contrast, the ECB's policies are more local in nature and mainly affect European economies.

The differences between the Anglo-Saxon and European models of the financial system shown above do indeed have an impact on monetary policy making by the FED and ECB. In the US, the dominance of capital markets means that the Fed must take into account the state of stock markets and asset inflation when making interest rate decisions. In contrast, the ECB, operating in a system based on universal banks, must focus on the stability of the banking sector and the availability of credit to businesses. The two models require different approaches, which differentiates the monetary policies of the Fed and the ECB. Besides, the indicated between the Anglo-Saxon and European models of the financial system are important from the point of view of comparing the monetary policy applied by the Central Bank of Poland to the analogous policies of the FED and ECB. The banking system in Poland, since 1989, had been rebuilt in the new market economic realities mainly according to the German and French patterns, *i.e.*, the European model of the financial system, which was important in the context of Poland's future accession to the European Union, which occurred later in 2004. The idea was to make the banking system in Poland as compatible as possible in terms of system, norms, procedures, technology, etc. to the banking systems of Western European countries, since Poland was to become part of a common economic organism, such as the European Union⁵⁶. The aforementioned adjustment process,

55 D. Szybowski *et al.*, *Activating interventionist monetary policy of the European Central Bank in the context of the security of the European Financial System* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój w Warszawie, No. 2 (4) 2016, pp. 141–142. ISSN 2450-2146.

56 A. Chojan *et al.*, *The development of the banking system in Poland determined by the processes of adjustment to the normative and technological standards of The European Union and contemporary processes of economic and informational globalization* (in:) "International Journal of Legal Studies", International Institute of Innovation "Science-Education-Development" in Warsaw, December 2018, No. 2 (4) 2018, pp. 346–347. ISSN 2543-7097.

which took place mainly in the 1990s, generally went smoothly⁵⁷. Poland has built a strong banking system that has been resilient to various international financial and economic crises. The Central Bank of Poland played a key role in this regard⁵⁸.

7.12. Interventionist actions by the Fed and ECB during the 2008 global financial crisis

Interventionist measures by central banks, such as the Asset Purchase Programmes conducted by the Fed in response to the 2008 global financial crisis, have sparked widespread debate and varied assessments among economists and analysts. The programmes were aimed at stabilising the banking sector, which was on the verge of collapse due to the global subprime financial crisis, and injecting liquidity into the financial system to prevent a further deepening of the crisis.

Supporters of the Fed's actions argued that central bank interventions, including massive asset purchases from commercial banks⁵⁹, were necessary to avoid a more severe economic catastrophe. They believed that the 2008 crisis could have escalated into an even deeper recession or economic depression had it not been for the Fed's actions. The purchase of "toxic assets" was aimed at restoring confidence in the banking system and preventing market panic. This thesis finds support among Keynesians, who argue that active interventions by governments and central banks in times of crises are key to maintaining the stability of the economy and limiting the negative effects on society⁶⁰.

An example of this is the TARP (Troubled Asset Relief Programme), which allowed commercial banks and other financial institutions to sell low-value assets,

57 W. Wereda et al., *Globalizacyjne i normatywne determinanty procesu doskonalenia zarządzania bankowym ryzykiem kredytowym w Polsce* (in:) "International Journal of Legal Studies", Międzynarodowy Instytut Innowacji „Nauka – Edukacja – Rozwój”, Warsaw, December 2018, No. 2 (4) 2018, pp. 267–268. ISSN 2543-7097.

58 S. Gwoździewicz, D. Prokopowicz, *System and normative adaptation of the financial system in Poland to the European Union Standards – The Next Stage* (in:) *Globalization, the State and the Individual*, "International Scientific Journal", Free University of Varna "Chernorizets Hrabar", Chayka, Varna, Bułgaria 9007, Varna 2016, No. 4 (12) 2016, pp. 81–82. ISSN 2367-4555.

59 A. Dmowski et al., *Finanse i bankowość. Teoria i praktyka*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2008, pp. 176–177. ISBN 978-83-7251-953-5.

60 A. Sadłowski, *Keynesowska analiza wpływu inicjalnej zmiany popytu autonomicznego na dochód i produkcję w stanie równowagi* (in:) "Współczesna Gospodarka", 2023, No. 16(1), pp. 1–9. DOI: 10.26881/wg.2023.1.01.

which helped avoid major bankruptcies and strengthen their balance sheets. Many believe that the programme has prevented a complete collapse of the financial system, which could have led to a prolonged recession. However, critics of these measures point out that the state aid directed at the banks was unfair and immoral. They claim that commercial banks themselves led to the crisis through irresponsible risk management, especially in the subprime mortgage sector, and by selling “toxic” financial instruments that were packaged as safe investments. Critics argue that these banks should have suffered the consequences of their actions, instead of being bailed out by governments with taxpayers’ money. One of the key arguments of the opponents of interventionism is the phenomenon of so-called “moral hazard”, which refers to a situation in which financial entities take excessive risks, knowing that they will be bailed out by the state in case of problems. As a result, the 2008 crisis did not lead to sufficient reforms in the financial sector, and the banks were able to continue their operations after receiving the bailout, often in a similar manner as before the crisis.

In addition, critics point out that the costs of these measures were largely passed on to the public. The public bailout of banks was financed by taxpayers’ money, while at the same time many people lost their homes, jobs, and savings as a result of the crisis. In their view, bailing out financial institutions at the expense of the public went against the principle of economic justice. In addition to the ethical and moral aspects of the Fed’s and ECB’s actions, there are also questions about the long-term economic effects. The introduction of billions of dollars in new money into the economy may have contributed to later inflationary problems, which has been the subject of criticism from monetarists⁶¹. Increasing liquidity in the banking system through asset buybacks may also have led to income inequality as financial institutions mainly received support rather than households directly.

Some economists, such as Joseph Stiglitz, have pointed out that the funds should have been directed more toward supporting individuals who lost their jobs or homes, instead of bailing out the financial institutions responsible for the crisis. On the other hand, representatives of institutions such as the Fed argued that stabilising the banks was crucial to the overall health of the economy, and in the long run also benefited citizens through faster economic recovery. Central bank interventions in the 2008 crisis also had important policy implications. State

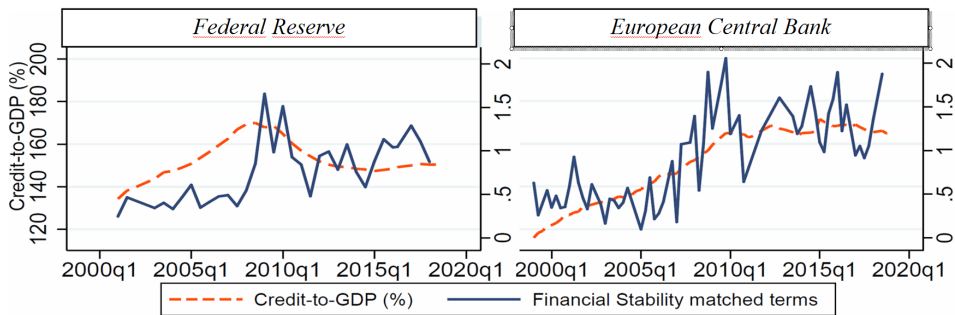
⁶¹ L. Marchiori, *Monetary theory reversed: Virtual currency issuance and the inflation tax* (in:) “Journal of International Money and Finance”, October 2021, Volume 117, No. 102441 (<https://doi.org/10.1016/j.jimonfin.2021.102441>).

aid to the financial sector was one of the key factors that led to the rise of anti-system movements such as Occupy Wall Street in the US. These movements highlighted social inequalities and injustice in the distribution of the costs of the crisis, where profits were privatised, and losses were made public. There have also been a number of policy initiatives calling for greater regulation of the financial sector and limiting the banks' influence on the economy.

In view of the above, the Fed's and ECB's interventions during the 2008 global financial crisis to buy back lost assets were effective in preventing a larger economic collapse, but at the same time faced criticism on ethical grounds and long-term economic consequences. Ultimately, the debate over the legitimacy of these actions remains open, and their consequences will be analysed by economists and economic historians for years to come.

The chart below shows the credit-to-GDP ratio and the financial stability issue for the two central banks being compared: Federal Reserve Bank and European Central Bank for the period of almost two decades ending just before the Covid-19 pandemic.

CHART 9. Credit-to-GDP and focus on financial stability in the parliamentary hearings, by central bank



Note: credit-to-GDP is total credit to private non-financial sector, using BIS data. Data for the ECB refer to the euro area.

Source: N. Fraccaroli et al., *Central Banks in Parliaments: A Text Analysis of the Parliamentary Hearings of the Bank of England, the European Central Bank and the Federal Reserve* (in: "ECB Working Paper Series", European Central Bank, No. 2442 / July 2020, p. 46.

7.13. Evaluation of the legitimacy and effectiveness of interventionist measures taken by the central banks of the FED and ECB in the situation of rising inflation in the period between 2021 and 2023

Between 2021 and 2023, interventionist measures by central banks, such as the Federal Reserve Bank (FED) and the European Central Bank (ECB), became the subject of widespread debate. The discussion has focused on both the legitimacy and effectiveness of their monetary policies in the face of soaring inflation due to a number of global factors⁶², such as the COVID-19 pandemic, disrupted supply chains, and the war in Ukraine

Most economists agree that the rapid rise in inflation in 2021–2022 required a response from central banks. High inflation, in some cases in excess of 9 per cent (especially in the US and eurozone), required action to counter erosion of the value of money and weakening of household purchasing power. The Fed began a cycle of interest rate hikes in March 2022, which many commentators felt was appropriate, though overdue. Some critics argued that action should have been taken earlier – especially given that signs of sustained inflation had already begun to appear by late 2021⁶³. However, the Fed's supporters claimed that the delay in making a decision was related to uncertainty about the sustainability of inflation as it was initially considered a temporary phenomenon resulting from temporary supply shocks.

The ECB was more cautious in its actions, delaying interest rate hikes until July 2022. In this case, too, some experts felt that action was overdue, especially in the context of rising energy and food prices in Europe, which have had a significant impact on inflation. The interest rate hikes were aimed at curbing demand by reducing the availability of credit⁶⁴ and increasing borrowing costs, which in theory should reduce inflationary pressures. Both the Fed and the ECB consistently raised interest rates in 2022 and 2023. However, critics of these actions argued that high inflation

62 M. Matosek *et al.*, *Current and historical determinants of globalization processes* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji "Nauka-Edukacja-Rozwój", No 2 (8) 2018, Warsaw, December 2018, pp. 198–199. ISSN 2450-2146.

63 D. Prokopowicz, *The postcovid rise in inflation: coincidence or the result of misguided, excessively interventionist and monetarist economic policies* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 16 (2) 2022, December 2022, pp. 128–129. ISSN 2450-2146. DOI: 10.5604/01.3001.0016.3409.

64 A. Dmowski *et al.*, *Podstawy finansów i bankowości*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2005, pp. 253–254. ISBN 83-7251-552-2.

was primarily due to supply-side factors that monetary policy has limited influence over, such as disruptions in supply chains and energy commodity prices.

At the same time, some analysts praised the central banks' actions for their ability to "soften" the effects of inflation by controlling demand. The effectiveness of these policies could be seen especially in the second half of 2023, when inflation began to fall, which meant that the central banks' actions were beginning to have an effect. Beginning in mid-2024, signs of an economic slowdown started to appear, and inflation began to fall in many countries, including the US and the eurozone. Central banks, especially the Fed, were faced with a challenge – on the one hand, pressure to further reduce inflation, and on the other, the need to support the slowing economy.

In this situation, some experts believed that continuing restrictive monetary policy could lead to a recession. As a result, the Fed began lowering interest rates in the second half of 2024, which was met with mixed reactions. Supporters of the measures argued that they were necessary to prevent the economic slowdown from becoming too deep. Critics, however, argued that this could help maintain some inflationary pressures, especially with energy prices still high. The ECB, on the other hand, was more cautious due to the more diverse situation in eurozone countries – inflation fell faster in some countries, while it remained higher in others. Interest rate cuts were implemented later than in the US, allowing the situation to stabilise further.

In summary, opinions are divided on the legitimacy and effectiveness of the Fed's and ECB's interventionist measures. On the one hand, the central banks took necessary steps to fight inflation, although some of their decisions were seen as overdue. On the other hand, the 2024 interest rate cuts were a response to changing economic conditions but raise questions about whether they will have a lasting effect on economic stabilisation without a resurgence in inflation. These conclusions are based on analyses of a number of publications on the actions of central banks, both in the US and the eurozone.

7.14. Determinants of increasing gold reserves at central banks

In recent years, central banks around the world have been increasing their gold reserves for several key reasons, which stem from both dynamic changes in global markets and political and economic uncertainties. One of the main factors motivating these institutions to increase gold reserves is its status as a "safe haven"

in times of global economic and political uncertainty. Gold has been recognised for centuries as a stable means of storing value, especially at times when monetary systems may be threatened. Between 2020 and 2023, the world experienced various crises, such as the COVID-19 pandemic, supply chain⁶⁵ disruptions, high inflation, and the war in Ukraine, making gold more important as a means of securing value.

Another important reason for central banks to increase their gold reserves is to diversify their foreign exchange reserves. They seek to reduce dependence on a single currency, such as the US dollar or the euro. Against the backdrop of rising geopolitical tensions, such as the trade rivalry between the United States and China or sanctions imposed on Russia, many countries see gold as a more neutral asset, unrelated to the politics of individual countries. The increase in gold reserves gives central banks greater flexibility in situations of international tension.

Gold is also widely regarded as a hedge against inflation, which is particularly relevant in the context of the high inflation seen in 2021–2022. Central banks, including the Fed and ECB, have sought to raise interest rates to counter inflation; however, gold remains one of the assets that historically gains in value during periods of high inflation, when the value of money falls.

In addition, some central banks, especially in emerging economies, such as China, India, and Russia, see gold as a way to increase autonomy and independence from the dollar. In recent years, these countries have been increasing their gold reserves to strengthen their position in the global financial system and diversify the assets in their portfolios. Rising demand from central banks has been one of the important factors driving the gold price in recent quarters. Gold prices rose in 2022 and 2023, in part due to central banks' decisions to increase reserves. High demand, combined with limited supply, resulted in an increase in the value of the bullion. The increased interest in gold, both as a hedge against inflation and as a tool for diversifying foreign exchange reserves, underscores its enduring role in the global financial market in times of uncertainty.

In view of the above, the increase in gold reserves by central banks in recent years is due to a combination of geopolitical, economic, and financial factors.

65 K. Golczak et al., *Prognoza globalnego kryzysu finansowo-gospodarczego zdeteminowanego przez pandemię koronawirusa w obszarze gospodarczym, społecznym, politycznym i geopolitycznym. Prognoza kryzysu w obszarze gospodarczym* (in:) P. Soroka et al. (ed.) *Raport zawierający diagnozę i prognozę globalnego kryzysu finansowo-gospodarczego zdeteminowanego przez pandemię koronawirusa w obszarze gospodarczym, społecznym, politycznym i geopolitycznym*, Publishing house Elipsa, Warsaw 2021, pp. 97–98. ISBN 978-83-8017-375-0.

Central banks are seeking greater diversification, hedging their reserves against inflation, political tensions, and potential shocks to currency markets. Gold, being independent of currency risks, plays a key role in the reserve management strategies of state central banks.

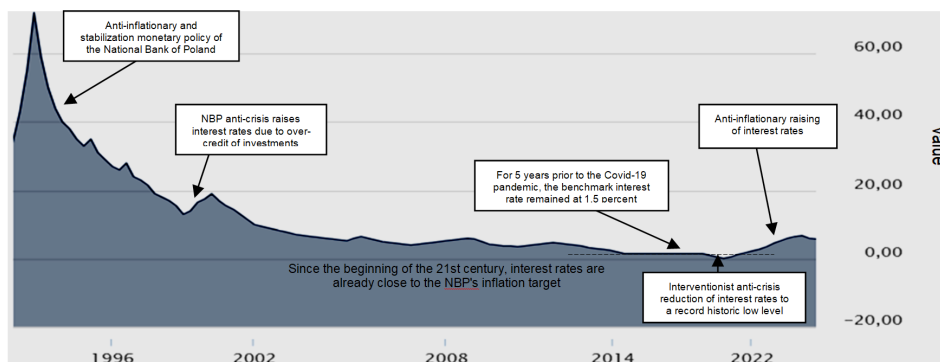
7.15. Monetary policy of the Central Bank of Poland versus the FED and ECB – similarities and differences

The monetary policy of the Central Bank of Poland (NBP) is distinguished by unique features that to some extent can be compared to the monetary policies of the Federal Reserve Bank (FED) and the European Central Bank (ECB). In the context of price stability and response to economic crises, the NBP has both similarities and differences with the two institutions.

Similarities with the Fed include flexibility in its approach to inflation. The NBP, like the Fed, focuses on price stability, but with a greater emphasis on stabilising economic growth. For example, in the face of crises such as the COVID-19 pandemic⁶⁶, the NBP has employed interest rate reduction policies and asset repurchase programmes, which is consistent with the Fed's actions in similar circumstances. Moreover, the NBP adjusts its monetary policy tools to changing economic conditions, which is also a characteristic of the Fed, which makes decisions based on macroeconomic data. The chart below shows changes in the level of the Central Bank of Poland's reference interest rate (from January 1990 to October 2024 in Poland).

On the other hand, similarities with the ECB are also noticeable, especially in terms of the focus on price stability. The NBP, like the ECB, seeks to keep inflation stable by setting an inflation target, which is a key element of both institutions' monetary policy. In addition, the NBP plays an important role in ensuring the stability of the financial system, as does the ECB, but the NBP's interventions are less complex compared to the ECB, which must take into account the diversity of the economies of European Union member states.

⁶⁶ P. Komorowski, D. Prokopowicz, *Impact of the coronavirus pandemic (Covid-19) on financial markets and the economy* (in: "International Journal of Legal Studies", Międzynarodowy Instytut Innowacji "Nauka – Edukacja – Rozwój", Warsaw, December 2021, Volume 10, No. 2 (10) 2021, pp. 93–94. DOI: 10.5281/zenodo.5851358. ISSN 2543-7097.

CHART 10. Reference interest rate of the Central Bank of Poland (from January 1990 to October 2024 in Poland)

Source: Financial portal Bankier.pl (<https://www.bankier.pl/gospodarka/wskazniki-makroekonomiczne/referencyjna-pol>), following Statistics Poland. Latest value: 5.75 per cent (as of Oct. 5, 2023).

As a result, although the NBP's monetary policy can be compared to that of the FED and the ECB, the differences in its approach to stabilising the economy and its responses to economic crises reveal the unique nature of the NBP in the context of Polish economic reality.

In view of the above, the NBP's monetary policy has elements from both the FED's and ECB's approaches, but in practice is more adapted to Poland's specific economic conditions. Therefore, it can be said that the NBP balances between the flexibility of the Fed's policy and the ECB's more conservative approach, adapting actions to local economic needs.

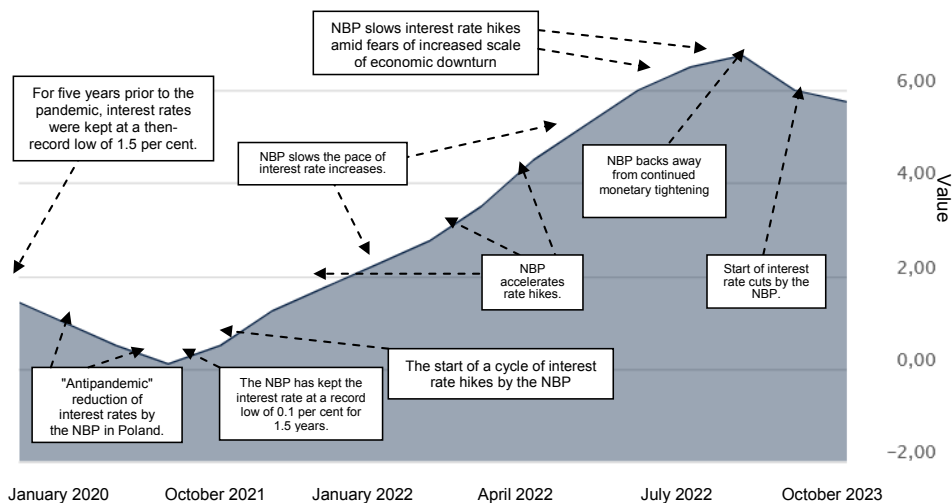
The central banks FED and ECB during the recent deep international financial and economic crises (Global Financial Crisis 2008, Pandemic Economic Crisis 2020) interventionistically lowered interest rates⁶⁷. On the other hand, when the economy was recovering from the recession and economic crisis, the rate of economic growth increased significantly, the prices of production factors rose and the governments of individual countries through mild fiscal policies and financial support programmes for economic entities, anti-crisis interventionist

67 B. Domańska-Szaruga, D. Prokopowicz, *Makroekonomiczne zarządzanie anty kryzysowe* (in:) 34 Zeszyty Naukowe Uniwersytetu Przyrodniczo – Humanistycznego w Siedlcach, nr 107, Seria: Administracja i Zarządzanie (34) 2015, Uniwersytet Przyrodniczo-Humanistyczny, Wydział Nauk Ekonomicznych i Prawnych, Siedlce 2015, pp. 41-42. ISSN 2082-5501.

financial subsidy programmes, and financial social support programmes for citizens on the basis of financial resources from the state's public finance funds generated high inflation⁶⁸, for example after the Covid-19 pandemic, from 2021, it was then that central banks radically changed their monetary policies by 180 degrees, *i.e.*, from mild, dovish anti-crisis interventionist monetary policy to tightened, hawkish anti-inflationary monetary policy⁶⁹.

The chart below shows changes in the Central Bank of Poland's benchmark interest rate from January 2020 to October 2024, taking into account significant economic and other events that may have had a significant impact on changes in monetary policy during the mentioned period.

CHART 11. NBP reference interest rate from January 2020 to October 2024



Source: Own compilation based on: Financial portal Bankier.pl (www.bankier.pl), following Statistics Poland data (latest figure: 5.75 per cent as of 5/10/2023).

68 D. Prokopowicz, *The postcovid rise in inflation: coincidence or the result of misguided, excessively interventionist and monetarist economic policies* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 16 (2) 2022, December 2022, pp. 121-122. ISSN 2450-2146. DOI: 10.5604/01.3001.0016.3409.

69 D. Szybowski, D. Prokopowicz, S. Gwoździwicz, *Activating interventionist monetary policy of the European Central Bank in the context of the security of the European Financial System* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 2 (4) 2016, pp. 140-141. ISSN 2450-2146.

Another important factor taken into account in the formation of monetary policy was the formation of certain levels of interest rates in individual countries as well as the formation of international interest rates. However, if almost at the same moment and on a similar scale, individual central banks change their interest rates, then these other issues, such as the formation of the exchange rate of the national currency, will not have to be considered as a key factor in the formation of interest rates since the occurring amplitudes of exchange rate changes and the frequency of their changes in the situation presented should not be high. This, of course, applies to the formation of exchange rates of currencies representing economies of similar size, such as the US and European Union economies. However, in the situation of economies of a much and many times different size, *i.e.*, primarily much smaller economic organisms with their own currency as, for example, in the situation of the Polish economy, then the formation of the exchange rate of the national currency PLN is characterised by a much higher level of volatility relative to other currencies.

The Central Bank of Poland, in situations arising during the development of global financial and/or economic crises, attempted to stabilise the strong and rapid drop in the PLN exchange rate occurring at the time. These were mainly the so-called verbal interventions of the NBP Governor implemented during extraordinary press conferences. Fortunately, the aforementioned verbal interventions usually turned out to be effective and cooled the appetite for accepting high levels of currency risk of investment banks and hedge funds based in London or New York playing with the Polish currency. Since the aforementioned verbal interventions usually proved effective, so it was unnecessary to use foreign exchange reserves in carrying out much more real interventions in the international currency markets.

Alternatively, the NBP's long-term strategy has led to a successive weakening of the Polish currency. Furthermore, the NBP in recent years has been conducting rather interesting and not fully transparent⁷⁰ financial operations in international financial markets, including international currency and securities markets resulting in diametrically changing annual financial results of the NBP, which resulted in showing either record high profits in the neighbourhood of PLN 10-11 billion or record multi-billion-dollar losses. Amid ongoing criticism since the 1990s

70 M. J. Lamla, D. V. Vinogradov, *Central bank announcements: Big news for little people?* (in:) "Journal of Monetary Economics", 2019, No. 108, pp. 25-26.

CHART 12. CPI inflation in Poland (in per cent) against the central bank's inflation target of the Central Bank of Poland (2002–2024)



Source: A. Wojciechowska, *Budżet państwa pod wodzą, tragiczny wynik państwowych spółek i inflacja w końcu w celu, ale nie w Polsce* (in: financial portal "Bankier.pl", Markets, October 5, 2024, (<https://www.bankier.pl/wiadomosc/Budzet-panstwa-pod-woda-tragiczny-wynik-panstwowych-spolek-i-inflacja-w-koncu-w-celu-ale-nie-w-Polsce-8823726.html>), accessed October 27, 2024, following Statistics Poland data.

by many independent economists, who argue against the practice of transferring nearly all of the NBP's annual profit to the state budget instead of using it to bolster foreign exchange and bullion reserves – which play a significant role in ensuring the financial system's security – the NBP has, in recent years, adopted a key strategic objective of increasing its reserves, including through successive gold purchases.

In view of the above, of the many different aspects of the shaped monetary policy and its main determinants presented above, it is the increase of reserves in gold that the NBP considers to be the most sensible solution to increase the security of the financial system. This thesis is confirmed by the fact that other central banks, including the central banks representing the world's largest economies discussed in this chapter, *i.e.*, the FED and the ECB, have also been increasing gold reserves in recent years. The issue of increasing these reserves is one of the key lessons learned from the situation and the negative effects of the largest global financial crisis that occurred in the 2008–2009 period, and actually began in the US as early as mid-2007.

7.16. The question of the impact of central banks' monetary policies on commercial banks' finances and central banking efficiency against the background of the national economy

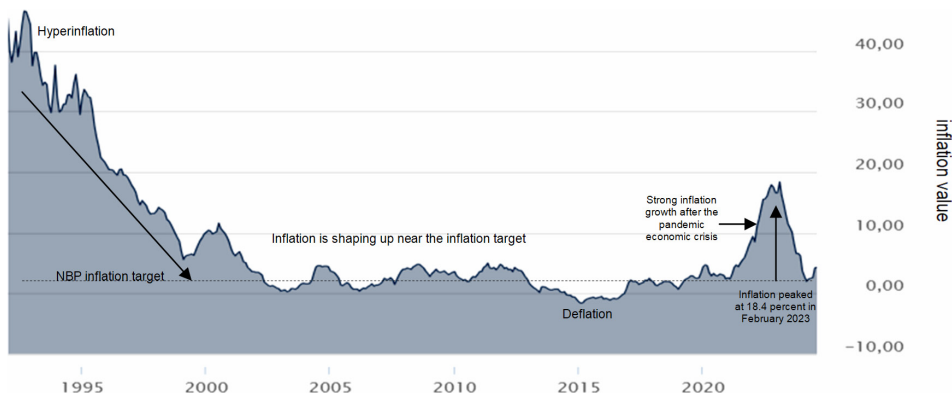
As demonstrated above, when a central bank implements anti-crisis measures by lowering interest rates, and commercial banks⁷¹ reduce interest rates on deposits and savings accounts more quickly and significantly than on loans, they widen the margin between these banking products, thereby increasing their earnings. This was the case from the beginning of the Covid-19 pandemic until mid-2021. Conversely, when the central bank implements anti-inflation⁷² measures by raising interest rates, then commercial banks tend to raise loan interest rates more quickly than the rates on savings accounts and deposits. As a result, commercial banks also increase the margin between these banking products and earn more. This was the case when, in the second half of 2021 or the first half of 2022; central banks raised interest rates as an anti-inflationary measure to curb the scale of rising inflation. Inflation that grew rapidly in many countries due to the introduction, during the Covid-19 pandemic, of a large amount of additional money into the economy without being covered by the products and services created and sold in the markets, *i.e.*, in the procedure of printing and introducing additional money into the economy, in which the central banks also played an important role. The chart below shows the evolution of inflation (y/y) in Poland from January 1992 to August 2024.

The aforementioned important role was even greater when the central bank directly bought government bonds to provide the aforementioned additional money to the government's anti-crisis aid programmes⁷³. Therefore, such periodic fluctuations, changes in the monetary policy strategies of central banks are usually favourable for commercial banks. Besides, the quantitative easing practices

71 A. Dmowski, J. Sarnowski, D. Prokopowicz, *Finanse i bankowość. Teoria i praktyka*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2008, pp. 182–183. ISBN 978-83-7251-953-5.

72 D. Prokopowicz, *The postcovid rise in inflation: coincidence or the result of misguided, excessively interventionist and monetarist economic policies* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 16 (2) 2022, December 2022, pp. 123–124. ISSN 2450-2146. DOI: 10.5604/01.3001.0016.3409.

73 S. Gwoździewicz, D. Prokopowicz, *The role and application of Keynesian macroeconomic anti-crisis theories in the context of development of the financial system in Poland* (in:) *Globalization, the State and the Individual*, "International Scientific Journal", Free University of Varna "Chernorizets Hrabar", Chayka, Varna, Bułgaria 9007, Varna 2015, No. 3(7) 2015, pp. 51–52. ISSN 2367-4555.

CHART 13. THE LEVEL OF INFLATION (Y/Y) IN POLAND FROM JANUARY 1992 TO AUGUST 2024

Source: Financial portal Bankier.pl (<https://www.bankier.pl/gospodarka/wskazniki-makroekonomiczne/inflacja-rdr-pol>), following Statistics Poland data. Latest value: 4.3 per cent (August 2024).

carried out by central banks during the major recent financial and economic crises also significantly helped commercial banks avoid situations of serious financial problems and, in the case of some banks, also avoid the scenario of bank failure. However, the costs of these practices were spread throughout the economy to the public. Many citizens considered this procedure as an example of social injustice and significantly reduced the level of public confidence in the banking system. This kind of procedure was also the reason for the public protests held outside Wall Street in New York when the 2008 global financial crisis erupted, including the Occupy Wall Street protests, in which protesters reported that profits were being privatised by banks and the costs were being passed on to citizens. At issue are the profits of commercial and investment banks, which made money from the crisis and additionally received cheap money from the central bank and many citizens lost their homes, jobs, livelihoods, found themselves on the street because of the 2008 global financial crisis, the origins of which can be traced back to the banking system itself, including ignoring good customer service practices, investors, and the sound execution of the credit risk management process⁷⁴.

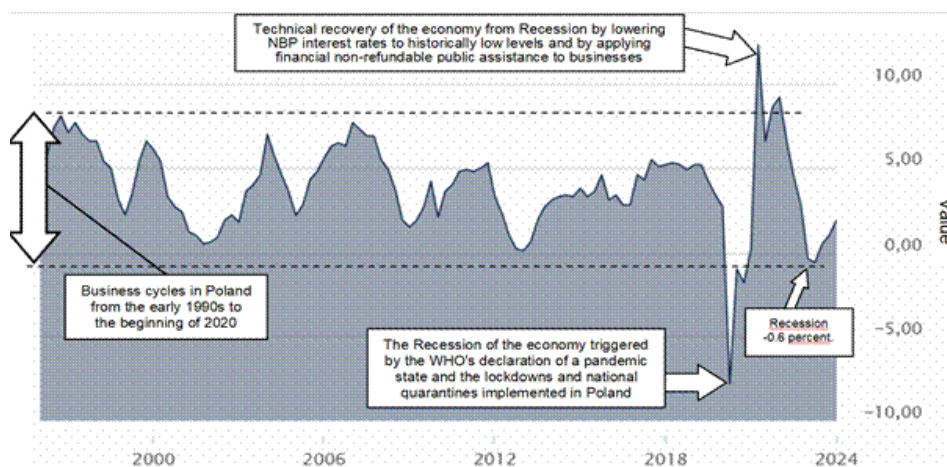
74 W. Wereda, D. Prokopowicz, B. Domańska-Szaruga, *Globalizacyjne i normatywne determinanty procesu doskonalenia zarządzania bankowym ryzykiem kredytowym w Polsce* (in: „International Journal of Legal Studies”, Międzynarodowy Instytut Innowacji „Nauka – Edukacja – Rozwój”, Warsaw, December 2018, No. 2 (4) 2018, pp. 281–282. ISSN 2543-7097.

The issue of the impact of central banks' monetary policy on commercial banks' finances and the efficiency of central banking against the national economy is described below using the example of the post-pandemic Covid-19 monetary policy of the Central Bank of Poland. When, after the Covid-19 pandemic, the Central Bank of Poland, from October 2021, began to raise interest rates to quench inflation, commercial banks were faster to raise interest rates on loans and much slower to raise interest rates on savings accounts and deposits, thanks to which they increased their margins and achieved record high revenues from sales and servicing of bank loans, thus showing highest profits on record in their financial statements. This translated into a downturn in the economy and even caused a recession in the economy in the 1st half of 2023, which reached -0.6 per cent. Analysts of the Central Bank of Poland did not include this issue in their projections of the impact of raising interest rates by the NBP on the economy.

It was only in July 2022, when the Treasury began offering government bonds to individual customers with significantly higher interest rates compared to previous years, that commercial banks were compelled to substantially increase the interest rates on savings accounts and deposits. Only from this point on, *i.e.*, after the NBP had already raised interest rates for more than half a year, did this raising begin to have a real anti-inflationary effect, that is, with an additional delay of more than half a year. In contrast, the deconflationary effect began to work from the very beginning of the NBP's raising of the aforementioned interest rates. This issue was not taken into account by the NBP analysts in their projections of the impact of the NBP's interest rate hikes on the economy. Earlier, during the onset of the first wave of the Covid-19 pandemic, central banks, including the Central Bank of Poland –following the example of institutions such as the Federal Reserve (FED) and the European Central Bank (ECB) – implemented significant anti-crisis, pro-cyclical interest rate cuts within a relatively short period. This measure aimed to reduce borrowing costs for citizens and businesses, boost liquidity in the banking sector, and support economic activity. These actions quickly had a pro-cyclical effect on capital markets, including securities and commodity markets, helping to halt stock market crashes and reverse downward trends into upward trajectories in these markets. The reduction of interest rates to historically low levels, such as the NBP's reference rate being lowered to 0.1 per cent, and maintaining this interventionist, anti-crisis rate for a year and a half, led to a significant increase in commercial bank lending, particularly in mortgage sales. The lack of a transparent information policy by the Central Bank of Poland – failing to adequately inform citizens, including potential

borrowers, that the reduced rates during the Covid-19 pandemic were not reflective of a stabilised economy but were instead exceptionally interventionist and temporary – resulted in a surge in mortgage-financed apartment purchases. This coincided with a rapid rise in the price per square metre of apartments, which benefited commercial banks⁷⁵ and developers building housing estates; however, it did not necessarily benefited citizens buying apartments more expensively and paying higher loan instalments already from the following year 2022, when rapurously from October 2021, the Central Bank of Poland began raising interest rates. The chart below shows the development of GDP levels in Poland from January 1996 to June 2024, taking into account the exceptional changes in economic growth rates during and immediately after the Covid-19 pandemic.

CHART 14. Development of the level of GDP in Poland (from January 1996 to June 2024)



Source: Financial portal Bankier.pl (<https://www.bankier.pl/gospodarka/wskazniki-makroekonomiczne/pkb-rdr-pol>), following Statistics Poland data. Latest value: 3.2 per cent (Q2 2024).

According to the Polish Constitution⁷⁶, the Central Bank of Poland (NBP) conducts monetary policy independently of the fiscal policy pursued

75 A. Dmowski, J. Sarnowski, D. Prokopowicz, *Finanse i bankowość. Teoria i praktyka*, Publishing house Centrum Doradztwa i Informacji Difin sp. z o.o., Warsaw 2008, pp. 176-177. ISBN 978-83-7251-953-5.

76 A. Pogódek, M. Maksymiuk, *Konstytucja jako ustawa zasadnicza*, (in:) *Prawo konstytucyjne*, ed. B. Szmulik, Wydawnictwo C. H. Beck, Warsaw 2016, pp. 32-33.

by the government⁷⁷. However, in the context of the recent financial and economic crises, the manner in which these two policies have been conducted has raised numerous doubts about the NBP's actual independence. In public debates and analyses of its functioning, allegations pointing to potential interdependencies between the NBP's monetary policy and the government's fiscal goals have repeatedly surfaced. On the other hand, the coordinated anti-crisis, interventionist measures implemented during financial and economic crises under the NBP's monetary policy and the government's fiscal policy may have proved more effective. However, on more than one occasion, these actions implemented within the framework of the NBP's monetary policy and the government's fiscal policy were carried out in such a way that instead of supporting each other, they cancelled each other out. This was the case, for example, following the Covid-19 pandemic, beginning in 2021, when the NBP implemented anti-inflationary interest rate hikes while the government pursued mild socioeconomic policies supported by financial subsidy programmes.

7.17. The past and future of central banks' monetary policies, including the Federal Reserve Bank, the European Central Bank, and the Central Bank of Poland

The importance of central banking monetary policy, especially in the context of the growing number of financial and economic crises, has undergone tremendous growth in recent decades. Beginning in the 1970s, major structural changes in the international financial system led to an increase in the importance of decisions made by central banks, such as the Federal Reserve Bank (FED), the European Central Bank (ECB), and the Bank of Japan. In 1971, when the US President Richard Nixon announced that dollar would no longer be convertible into gold, the Federal Reserve Bank's breaking of gold parity resulted in a shift from a system based on fixed exchange rates to a floating exchange rate system. Such a change increased volatility in the foreign exchange market and exchange rate risk, leading to the need for more regular intervention by central banks to counter potential crises.

⁷⁷ W. Den Haan et al., *The future of central bank independence: Results of the CFM-CEPR survey*. Cage background briefing series 75, September 2017.

Deregulation of financial markets, particularly in the United States and the United Kingdom, has enabled the liberalisation of capital flows and the development of new financial instruments, such as options, futures, and other derivatives. It also introduced new forms of risk, which significantly increased the complexity of the financial system. In the case of the 1997–1998 Asian crisis, for example, the liberalisation of the region's capital markets led to a surge of foreign investment inflows and subsequent outflows, with global consequences. Since 1997, the value of the derivatives market has increased more than tenfold, reaching some \$700 trillion by 2023, which illustrates the scale of the phenomenon vividly.

Modern economic theories explaining the growing role of central banks' monetary policy are mainly monetarism and neo-Keynesian theory referring to Keynesianism⁷⁸. Milton Friedman's monetarist theory states that inflation is a phenomenon associated with an excess supply of money. In the 1980s, the Fed's aggressive monetary policy under the leadership of Paul Volcker aimed to curb inflation by raising interest rates, which caused inflation to fall, although it triggered a short-term recession. In contrast, the neo-Keynesian approach, which gained popularity in subsequent decades, emphasises the importance of active intervention by central banks during periods of economic crises. Central banks, such as the ECB and the Fed, then began using monetary policy tools, such as interest rate cuts and quantitative easing, to promote economic growth.

At the same time, modern central banking theory focuses on financial stability as a key task of central banks, in addition to controlling inflation. Regulatory and supervisory activities, such as conducting stress-tests and monitoring leverage levels, have become increasingly important, especially after the 2008 financial crisis. Adequate risk control and monitoring of markets have become crucial to prevent destabilisation of the economy. Globalisation⁷⁹ and financial integration require greater coordination among central banks⁸⁰. For example, when the Fed raises interest rates, it attracts capital to the US, which can depreciate other countries' currencies, triggering crises in emerging markets.

78 J.M. Keynes, *The General Theory of Employment, Interest, and Money*, Palgrave Macmillan, 1936.

79 L.E. Armijo ed., *Financial Globalization and Democracy in Emerging Markets*, International Political Economy Series, Palgrave Macmillan Publishers Ltd., Houndmills, Basingstoke, Hampshire, New York 2001.

80 S. Gwoździewicz, D. Prokopowicz, *Globalization and the process of the system and normative adaptation of the financial system in Poland to the European Union standards* (in:) *Globalization, the State and the Individual*, "International Scientific Journal", Free University of Varna "Chernorizets Hrabar", Chayka, Varna, Bułgaria 9007, Varna 2016, No. 1(9) 2016, pp. 67–68. ISSN 2367-4555.

The growing importance of monetary policy is also evident in the data. During the COVID-19 pandemic, major central banks cut interest rates to record lows, and the Fed's balance sheet grew from about \$4.5 trillion in 2019 to more than \$7 trillion in 2021, demonstrating the scale of interventions to stabilise the economy. Global debt rose from \$164 trillion in 2007 to more than \$281 trillion in 2020, underscoring the huge role of central banks' rescue and stimulus efforts. Ultimately, monetary policy and central banking have become not only instruments for managing inflation, but also key tools for economic stabilisation and risk management in the face of increasingly frequent financial crises.

The monetary policies of central banks, especially the Federal Reserve Bank and the European Central Bank, have assumed exceptional importance in recent decades, playing a key role in stabilising the economy and countering financial and economic crises. The abandonment of gold parity in the 1970s and the deregulation of financial markets led to significant changes, including an increase in exchange rate volatility and increased risks in capital markets. Central banks were forced to use a variety of tools. During downturns, they lowered interest rates, stimulating the economy by increasing the availability of capital, while during economic booms and rising inflation; they raised interest rates to control the pace of growth and counter excessive debt. Exceptional crises, such as the one in 2008, forced central banks to use non-standard tools, such as quantitative easing (QE), which consisted of massive asset purchases and increased liquidity to stabilise the banking sector and support economic growth⁸¹.

However, contemporary challenges, including demographic changes such as an aging population, could erode the effectiveness of traditional central bank actions, leading to stagnation similar to what Japan has experienced since the 1990s. In such a scenario, economic growth could be constrained by low productivity and innovation, and anti-crisis measures may not have the desired effect. Counteracting stagnation could be the intensification of labour immigration, automation of processes, development of digitalisation⁸² of business operations, and implementation

81 B. Domańska-Szaruga, D. Prokopowicz, *Makroekonomiczne zarządzanie antykryzysowe* (in:) 34 Zeszyty Naukowe Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach, nr 107, Seria: Administracja i Zarządzanie (34) 2015, Uniwersytet Przyrodniczo-Humanistyczny, Wydział Nauk Ekonomicznych i Prawnych, Siedlce 2015, pp. 42–43. ISSN 2082-5501.

82 A. Gołębiowska et al., *Growing importance of digitalization of remote communication processes and the internetization of economic processes and the impact of the SARS-CoV-2 (Covid-19) coronavirus pandemic on the economy*, (in:) A. Gołębiowska, M. Such-Pyrgiel, (ed.), "Socio-economic and legal dimensions of digital transformation. Selected contexts", Publishing House SGSP, Warsaw 2021, pp. 238–239. ISBN 978-83-961824-4-9.

of modern technologies, such as Big Data Analytics⁸³, generative artificial intelligence⁸⁴, cloud computing, Internet of Things, digital twins, and other Industry 4.0 technologies to make economic processes more efficient. Alongside technological advancement, a green transformation of the economy is essential, involving a shift to low-carbon, sustainable production models. This transition requires both monetary policy support and substantial investment to address climate and environmental challenges⁸⁵ while fostering stable development.

As the risks associated with the climate crisis become more apparent, central banks, such as the Federal Reserve Bank and the European Central Bank, are beginning to recognise the need to incorporate climate change⁸⁶ risks into their risk management strategies. In response to the growing risks associated with global warming, both institutions are taking steps to strengthen the resilience of economic and banking systems to potential destabilisations caused by these changes.

In terms of climate risk management, the Fed and ECB are developing tools that take into account the effects of climate change. The ECB is conducting studies on the impact of these changes on financial stability and is introducing a “green finance” policy aimed at promoting sustainable development. As part of this policy, the ECB is analysing the risks associated with lending to sectors exposed to the effects of climate change. At the same time, both the ECB and the Fed are taking steps to support investment in the green transition. The ECB has launched a bond-buying programme related to green investments, and the Fed is promoting loans for renewable energy projects. An example of their commitment is the ECB’s issuance of €4 billion in green bond purchases in 2021.

83 W. Pizło *et al.*, *The importance of Big Data Analytics technology in business management* (in:) “Cybersecurity and Law”, No. 2 (10) 2023, Akademia Sztuki Wojennej, Akademickie Centrum Polityki Cyberbezpieczeństwa, Warsaw 2023, pp. 276–277. ISSN 2658-1493 DOI: <https://doi.org/10.35467/cal/174940>.

84 D. Prokopowicz, *Opportunities and threats to the development of Artificial Intelligence applications and the need for normative regulation of this development* (in:) „International Journal of Legal Studies”, Międzynarodowy Instytut Innowacji “Nauka – Edukacja – Rozwój”, Warsaw, December 2023, No. 2 (14) 2023, pp. 103–104. DOI: 10.5604/01.3001.0054.2699, ISSN 2543-7097.

85 W. Jakubczak *et al.*, *The Key Security Problems Related to the Pro-Environmental Economic Transformation and the Implementation of the Principles of Sustainable Development into the Economy* (in:) “European Research Studies Journal”, Vol. XXIV, Issue 4B, 2021, pp. 225–226. DOI: 10.35808/ersj/2654.

86 M. Such-Pyrgiel *et al.*, *Human security as an element of the concept of sustainable development in international law* (in:) “Journal of Modern Science”, Issue 3/2023 vol. 52, Wyższa Szkoła Gospodarki Euroregionalnej, pp. 47–48. ISSN 1734-2031. eISSN 2391-789X. DOI: 10.13166/jms/173159.

In the context of new technologies, central and commercial banks are implementing Industry 4.0-related solutions⁸⁷, such as Big Data Analytics⁸⁸, to analyse data on the impact of climate change on economies. The use of cloud computing and artificial intelligence enables more efficient modelling of risks and faster responses to changes in the economic environment. An example is the analysis of large datasets on climate change, which allows better prediction of its impact on the financial sector and thus more informed investment decisions.

Climate security experts recommend several measures that can increase the resilience of banking systems to the effects of climate change. They stress the importance of integrating climate risks into banks' daily operations and long-term strategies. They also suggest that banks conduct regular stress tests, assessing how their portfolios might respond to different climate change scenarios. In addition, they recommend increasing international cooperation in sharing information and best practices in climate risk management.

In comparing the FED's and ECB's activities with the Central Bank of Poland, it can be seen that while the FED and ECB are taking intensive actions on sustainability, the NBP is also beginning to recognise the importance of climate risks, but its actions are less intensive. The NBP is introducing programmes to promote green financing, but inadequate resources and a lack of adequate regulation may limit its ability to act in this area. As an example of the differences, the ECB has much greater capacity to intervene in monetary policy in the context of financing green projects, while the NBP is trying to align its activities with the EU requirements, but its influence is limited.

Accordingly, in the face of the growing climate crisis, central banks, including the Fed and the ECB, are recognising the need to integrate climate risks into their management strategies. While both institutions are taking concrete steps to build more resilient financial systems, there is a need for further reforms to deal more effectively with the growing risks of climate change. The implementation of new technologies and the development of sustainable financial practices are key to future economic stability in the face of global climate challenges.

87 W. Jakubczak et al., *The Legal and Security Aspects of ICT and Industry 4.0 Importance for Financial Industry 4.0 Development* (in:) "European Research Studies Journal", Volume XXIV, Issue 4B, 2021, pp. 169–181. DOI: 10.35808/ersj/2651.

88 M. Such-Pyrgiel et al., *The role of Big Data and Data Science in the context of information security and cybersecurity* (in:) "Journal of Modern Science", Issue 4/2023 Vol. 53, Wyższa Szkoła Gospodarki Euroregionalnej, 2023, pp. 25–26. ISSN 1734-2031. DOI: 10.13166/jms/177036.

Conclusions

The interventionist measures taken by central banks, such as the Federal Reserve Bank and the European Central Bank, in response to the global financial crisis in 2008 and the COVID-19 pandemic in 2020, have generated much debate about their legitimacy and effectiveness. Key aspects of these actions and their similarities and differences are important part of the analysis of monetary policy at these critical moments. The legitimacy of central banks' actions can be considered in the context of stabilising financial markets and rescuing the economy. In the face of the 2008 crisis, the Fed quickly implemented quantitative easing (QE) programme, which involved buying bonds to increase liquidity in the market. The ECB has also adopted similar measures to support the eurozone⁸⁹. In 2020, the Fed lowered interest rates to zero and launched corporate assistance programmes to protect jobs and reduce bankruptcies⁹⁰.

As for the effectiveness of the measures, the rapid response of central banks was key, helping to restore confidence in the financial systems⁹¹. Studies have shown that these measures have prevented even more crises⁹². Nevertheless, critics point out that the long-term application of quantitative easing policies can lead to problems such as socioeconomic inequality and the dependence of markets on monetary stimulation⁹³.

Similarities in the Fed's and ECB's monetary policies include the use of quantitative easing as the main instrument in response to crises, which has been key to increasing liquidity in the financial system. Both central banks also chose to lower interest rates to support economic activity, which is a standard monetary policy tool⁹⁴.

89 J.E. Gagnon *et al.*, (2011). *The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases* (in:) "International Journal of Central Banking", No. 7(1), pp. 3–43.

90 M. McCracken, (2020). *Federal Reserve's Emergency Actions in Response to COVID-19* (in:) *Federal Reserve Bank of St. Louis Review*, No. 102(3), pp. 107–120.

91 D. Prokopowicz, *The Shadow Banking as an Example of Inefficiencies in the Functioning of the Banking System in Poland* (in:) "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 1 (3) 2016, pp. 110–111. ISSN 2450-2146.

92 S. Blinder, *After the Music Stopped: The Financial Crisis, the Response, and the Work Ahead*. New York: Penguin Press, 2013.

93 W.H. Buiter, *The Eurozone Crisis: A Flawed Economic and Monetary Union*. New York: Oxford University Press, 2014.

94 J.H. E. Christensen, G.D. Rudebusch, *The Response of Term Rates to Asset Purchase Announcements* (in:) "International Journal of Central Banking", 2012, No. 8(1), pp. 1–35.

However, there are also significant differences in the monetary policies of the two banks. During the 2008 financial crisis, the ECB's actions were less aggressive as compared to the Fed, as the ECB did not introduce quantitative easing until 2015. This delay prompted criticism from some economists, who believed it contributed to the deepening of the eurozone crisis⁹⁵. In 2020, both banks' actions were more focused on saving the economy in the face of the pandemic, unlike in 2008, when the main goal was to stabilise the financial system. The COVID-19 crisis had a stronger impact on real economies, requiring a more flexible approach to monetary policy⁹⁶.

In view of the above, the interventionist actions of central banks in the face of financial crises, such as those of 2008 and 2020, have sparked widespread debate about their legitimacy and effectiveness. While similarities in the application of quantitative easing and interest rate cuts are apparent, differences in the scale, scope, and objectives of the actions show that central banks have tailored their strategies to the specifics of a given crisis.

In response to the economic crisis triggered by the COVID-19 pandemic in 2020, central banks, such as the Federal Reserve (FED) and the European Central Bank (ECB), applied extremely soft monetary policies⁹⁷ aimed at countering the recession. By lowering interest rates to record lows and injecting huge amounts of additional money into the economy through quantitative easing programmes, these banks sought to lower borrowing costs, support consumption, and stabilise financial markets. The effect of these measures was to increase liquidity in the financial system, which helped revive the economy, but at the same time caused inflation, which began to rise rapidly from 2021⁹⁸. Excessive money supply without coverage in the production of goods and services, problems with supply chains, and a sudden increase in demand after the end of the lockdowns created

95 O. Issing, *Monetary Policy in the Euro Area: What We Have Learned and What We Still Need to Learn*. Cambridge: Cambridge University Press, 2014.

96 K. Rogoff, *Crisis Economics: A Crash Course in the Future of Finance*. New York: Penguin Press, 2020.

97 D. Prokopowicz, *A safe monetary central banking policy as a significant instrument for liquidity maintenance in the financial system* (in: "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji "Nauka – Edukacja – Rozwój", No. 2 (8) 2018, Warsaw, December 2018, pp. 127–128. ISSN 2450-2146.

98 D. Prokopowicz, *The postcovid rise in inflation: coincidence or the result of misguided, excessively interventionist and monetarist economic policies* (in: "International Journal of New Economics and Social Sciences", Międzynarodowy Instytut Innowacji Nauka – Edukacja – Rozwój, Warsaw, No. 16 (2) 2022, December 2022, pp. 127–128. ISSN 2450-2146. DOI: 10.5604/01.3001.0016.3409.

inflationary pressures⁹⁹, forcing the FED and ECB to reverse policy and raise interest rates to control it. Although the two institutions acted in a similar direction, they differed in the speed and scale of their actions. The Fed, reacting more quickly and aggressively, raised interest rates in the US earlier, while the ECB was more cautious due to the eurozone's diversified economies. Ultimately, although tighter monetary policy helped lower inflation, the challenges of maintaining price stability and economic recovery highlighted the difficulties of managing monetary policy amid global crises and market imbalances.

Between 2021 and 2024, central banks, including the Federal Reserve Bank (FED) and the European Central Bank (ECB), used tightened monetary policy in response to soaring inflation, resulting from post-COVID-19 pandemic disruption, problems in supply chains, and rising energy prices. Their main tool was interest rate hikes, aimed at curbing demand, reducing consumption and investment, and cooling the labour market. The goal of these actions was to bring inflation down to levels consistent with their long-term targets of around 2 per cent. The FED and the ECB took similar steps, although they differed in the speed of their response and the scale of their actions due to different economic conditions and inflationary structures in the United States and the eurozone. The FED began increases earlier and at a more aggressive pace due to higher inflation growth in the US, while the ECB had to take into account Europe's greater dependence on energy prices and the more diverse economic situation of its member countries. Although the measures taken brought inflation down to target levels in the first half of 2024, inflationary pressures returned in the second half of that year as a result of geopolitical tensions and rising commodity prices. Consequently, monetary policy proved effective in the short term, but the difficulty of maintaining price stability in the long term revealed the complexity of conducting an effective fight against inflation in a changing global economic environment.

To recap, central bank interventions during financial crises, including the 2008 global crisis and the 2020 pandemic economic crisis, revealed both parallels and differences in the actions taken. The key tools were interest rate cuts and quantitative easing programmes to stimulate the economy and increase market liquidity. In the context of the COVID-19 crisis, the extensive fiscal support programmes introduced for companies and citizens contributed to rising inflation, which

99 A. Leandro, J.E. Llorens, *The impact of the COVID-19 outbreak on European inflation*, 2020 (<http://www.caixabankresearch.com/impact-covid-19-outbreak-european-inflation>), accessed on 15 October 2024.

ultimately forced a tightening of monetary policy in 2022. Although the instruments used were similar, the differences in the nature of the crises and inflationary responses significantly affected the effectiveness of central banks, which sought to stabilise the economy while risking a slowdown. The increase in cyber-crime threats¹⁰⁰ has prompted banks to introduce innovative¹⁰¹ security systems and cooperate with security agencies¹⁰². Additionally, in response to climate risks, the Federal Reserve and ECB are developing instruments to manage climate risks, including promoting green bonds and investments in renewable energy sources. Experts note the need to integrate climate risks into monetary policy and the importance of further regulatory reforms to increase the resilience of financial systems to future crises. The Central Bank of Poland, despite its interest in sustainable development, lags behind Western central banks. In the face of economic and climate crises, it is crucial to increase international cooperation and implement innovative financial practices to contribute to economic stability and protect against future risks.

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