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EURASIANOMICS

Sustainable and Innovative Economic Policy Strategies in Eurasia

2024

EDITORS
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A study volume of
the Magyar Nemzeti Bank
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Foreword by Governor György Matolcsy

There is a simple principle that can help achieve success in every field of human life: Individuals and communities should build on their strengths and avoid their weak points. While this may sound obvious, in practice it is frequently overlooked. Nowadays, in a century full of challenges, it is high time to identify our unique, deep-rooted strengths, which will catalyse competitiveness and long-term sustainable development.

The 21st century has been characterised by economic crises, climate change and geopolitical instability. So far, however, the responses to these challenges have not solved the issues impacting the global community, and thus I believe that we should not shy away from seeking new, unexplored routes. We need to resort to our strengths to provide solutions from a fresh perspective and create new frameworks that rely on the four pillars of talent, technology, knowledge and capital. Nowadays, with digitalisation and sustainability shaping development trajectories, mere economic growth is insufficient for a nation's success; instead, it is essential to achieve sustainable economic growth in conjunction with a consistent rise in productivity. In the current, fast-changing environment, the synergy of talent, knowledge, technology and capital can form the foundation for an innovative economic strategy aimed at fostering sustainable economic growth.

Central banks must also contribute to creating this four-pillar foundation, as they play an increasingly important role in addressing the factors that influence the emerging new world order. These factors include the slowing pace of the world economy, the challenges of global geopolitical tensions, the rapid development of technology and climate change. One crucial element for effective crisis management and adaptation lies in the proactive measures taken by central banks and monetary

authorities. This involves a comprehensive understanding of the causes, effects and interrelations of geopolitical processes.

Of the four pillars, talent is increasingly assuming the role of capital as a vital component of production in the global economy, particularly during the current fourth industrial revolution. Talents are pivotal in the creation and application of novel technologies, processes and concepts that promote more efficient resource utilisation and minimise environmental consequences. The incorporation of talent in critical sectors – such as renewable energy, sustainable agriculture and technology – can expedite the shift towards a greener economy. As skilled professionals apply their expertise to develop sustainable solutions, they play a vital role in job creation and economic diversification, ensuring that growth is not dependent solely on limited resources. By cultivating talent through education, training and supportive policies, countries can realise their full economic potential while at the same time progressing towards sustainable development objectives that serve both present and future generations. Nations with small yet open and innovative economies are poised to emerge as significant beneficiaries in the future due to their competitive advantages, such as their high-quality talent pool.

In terms of ensuring the economy's long-term sustainability, technology plays an essential part that cannot be ignored. By enabling the creation of renewable energy solutions, sophisticated manufacturing techniques and intelligent infrastructure, and by incorporating these developments into the national economy, technology assists economies in lowering their carbon emissions while sustaining productivity levels. Furthermore, the incorporation of digital technologies allows nations to improve resource utilisation, reduce waste and boost operational efficiency, resulting in more sustainable practices. Technology plays a crucial role in creating new economic opportunities, promoting inclusive growth and democratising economic participation. It contributes to improving social equity and empowers marginalised

communities by providing them with the necessary resources to thrive in today's economy. In addition, advanced educational technologies play a crucial role in workforce development by providing individuals with essential skills, enabling them to adjust to the continuously changing job market influenced by digital transformation. By emphasising technological innovation and its implementation, countries can create a future that harmonises economic progress with environmental stewardship and social equity, ultimately fostering a more sustainable and resilient global economy.

While all nations have the necessary skills and resources for acquiring knowledge, there are differences in their ability to utilise these factors, leading to unequal levels of economic development. Knowledge, encompassing both formal education and hands-on experience, is essential for the adaptation to digital transformation and addressing the changing demands of the market. It serves as a catalyst for innovation, empowering organisations to create effective technologies and processes that reduce environmental harm while enhancing productivity. Investing in human capital enables economies to develop a workforce capable of not only adapting to, but also spearheading transformative changes across diverse industries. Furthermore, the exchange of knowledge between nations can promote international cooperation and the sharing of best practices, ensuring that economic progress occurs without compromising environmental integrity or social equity.

Whether financial or intellectual, capital serves as the driving force behind research and development, allowing both businesses and governments to invest in innovative technologies that improve productivity and efficiency. By strategically allocating resources, societies can foster an environment that promotes growth, thereby easing the challenges posed by rising population demands and limited resources. Capital is essential for attaining sustainable economic growth, as it supplies the necessary resources for investments in infrastructure, technology and human capital.

Achieving sustainable economic growth depends not only on the accumulation of financial capital, but also on the efficient utilisation of physical and intellectual assets. Investments in renewable energy infrastructure play a crucial role in promoting environmental sustainability while simultaneously generating employment opportunities and stimulating economic growth. This establishes a beneficial cycle in which sustainable practices improve economic outcomes, allowing economies to expand without exhausting natural resources. Additionally, human capital acts as an essential element in leveraging technological progress. By investing in education and training, economies cultivate a workforce that is capable of fostering innovation and enhancing productivity. This, in turn, attracts additional investments, thereby reinforcing a growth cycle that emphasises sustainability. As businesses and nations become increasingly proficient in utilising these skills, they enhance their ability to respond to evolving market dynamics and environmental challenges, ensuring that growth can be sustained without jeopardising the prospects of future generations. The significance of social and institutional capital should also not be overlooked. Robust, transparent institutions foster trust and stability, which in turn attract both domestic and international investments.

The quartet of talent, technology, knowledge and capital enhances resilience to geopolitical challenges, allowing nations to work together and innovate in unison, thereby fostering stability in an interconnected world. It is crucial to establish gateway areas, defined as complex multi-hubs, which can act as platforms for cooperation between the West and the East. As financial, logistical, technological, innovation, intellectual and knowledge centres, multi-hubs function as key channels for trade, communication and cultural exchange, facilitating the smooth transfer of goods, ideas and innovations across borders. With rising geopolitical tensions and increasing economic disparities, the importance of these multi-hub platforms is amplified. Central banks significantly contribute to the development of multi-hubs by fostering financial

innovations, implementing central bank digital currencies and facilitating the green transition.

The 2020s mark the onset of the Eurasian era. Within this region, many instances of successful economic strategy transitions have emerged over recent decades. Notable examples include China, Japan, South Korea, Singapore and the United Arab Emirates. One common factor contributing to the success of these nations is their ability to identify and leverage their strengths. They have effectively generated demand with supply, such as through the cultivation of highly skilled labour and the promotion of world-class innovations. By focusing on knowledge-intensive industries, these countries have shifted their primary resource from material to intellectual, which offers a significant advantage in the Information Age. All of the nations recognised as leaders in sustainable development and growth possess a robust vision for the future, grounded in a strong traditional value system. Furthermore, they adeptly integrate modern and traditional elements, continuously explore new technologies, foster a world-class education system and prioritise talent, which is also an essential component of the Hungarian model.

The realisation of the potential advantages of the supercontinent hinges on strengthened cooperation among the nations within this region. I am confident that the fourth edition in this series of volumes of studies published by the Magyar Nemzeti Bank, the central bank of Hungary, will further position Hungary – capitalising on its strategic geographical location and the integration of talent, technology, knowledge and capital – as a centre for finance, logistics, technology, innovation, intellect and knowledge. This complex multi-hub will play a crucial role in connecting the West and the East. This volume aims to provide a comprehensive analysis of sustainable economic policy strategies and initiatives in Eurasia, with an emphasis on sustainable growth, competitiveness and advancements in technology and innovation. It includes contributions from

distinguished experts from China, Germany, Singapore, France, South Korea, the United Arab Emirates, Kazakhstan and Hungary, highlighting some of the most remarkable sustainable economic policy strategies in the Eurasian region. The cooperation with such esteemed international experts in preparing this work is a significant honour for the MNB. I am confident that, building on the success of the previous editions, this year's edition will attract a wide audience and stimulate ongoing discussions on this vital topic that is crucial for our future. As is written in The Great Plan, one of the chapters of the Book of Documents, the ancient Chinese political-philosophical and historical work that forms part of the Confucian canon: "When men (in office) have ability and administrative power, let them be made still more to cultivate their conduct; and the prosperity of the country will be promoted." This volume was compiled in this spirit.

György Matolcsy
Governor
Magyar Nemzeti Bank

Foreword by the Editors

Barnabás Virág, Deputy Governor, Magyar Nemzeti Bank

Marcell Horváth, Executive Director for International Relations, Magyar Nemzeti Bank

The 21st century marks the rise of the Eurasian era, in which China emerges as a major global player, challenging the United States in the world economy and international monetary system. The shifting world order highlights the importance of technology and its integration into the economy to secure a strong position internationally. Small countries can gain competitive advantages by focusing on the combination of talent, knowledge, technology and capital. With the rise of artificial intelligence and advanced technologies, the importance of talent will grow even more in the future. The Eurasian era is also seeing an increase in international conflicts, such as the US–China trade war and others, along with China advocating for the Global South and pushing for global governance reforms and multilateral cooperation for mutual benefit. Central banks play an increasingly important role in adapting to the changing geopolitical and economic environment. Considering this, the Magyar Nemzeti Bank, the central bank of Hungary (MNB), has prepared its latest publication in the series of volumes dealing with Eurasia for the fourth time in a row. This year, the studies presented focus on sustainable economic policy strategies in Eurasia. We anticipate that this edition will help foster international dialogue on the topic and contribute to the creation of a sustainable future in the long term.

The MNB firmly believes that the preservation, enhancement and expansion of multilateral cooperation across various levels is essential to achieve long-term sustainability. This sustainability is a fundamental characteristic of effective solutions to critical global

challenges, such as climate change and increasing geopolitical fragmentation. Its growing significance influences nearly every facet of life, encompassing international finance, economic decision-making, technological progress and even the monetary policy considerations of central banks. One significant concern addressed in the previous editions is the creation of a global consensus focused on sustainability, with due consideration of the developing Eurasian era. The 2024 edition examines the theme of sustainability in relation to a fundamental responsibility of national governments and central banks: the development of effective and innovative economic policy strategies across various countries.

Over the past decade, the MNB has placed significant emphasis on establishing, nurturing and expanding its international relations. In 2024, we are publishing the Eurasia volume of studies for the fourth consecutive year, on the sidelines of the Budapest Eurasia Forum. Following the presentation of our inaugural volume, entitled *Age of Eurasia – Future directions of knowledge, technology, money and sustainable geoeconomics*, at the Budapest Eurasia Forum in 2021, which aimed to promote Eurasian dialogue, we released the second volume, *The Future is Now – Eurasian central banks at the forefront of innovation*, in 2022. The third volume, *Geo Awakenings – Building a sustainable future in the emerging Eurasian era*, followed in 2023. Our goal for 2024 was to produce a collection that examines the interplay between economic policy and sustainability within the Eurasian context. The chapters address the topics of sustainable growth, competitiveness, and innovation and technology, illustrating the latest advances in sustainable and innovative economic policies across Eurasia. This volume aims to propagate the innovative viewpoint on Eurasian thought established in the earlier editions, to encourage research in this area, and, crucially, to facilitate future cooperation among scholars and experts from various countries and disciplines.

In the following, we provide a brief overview of the varied and stimulating subjects addressed in the individual studies in each chapter. The first study in the volume was written by Marcell Horváth, Zsófia Gulyás and Dávid Szabó (MNB). The 21st century marks the rise of Eurasia, with China emerging as a major power and challenging the United States in global economics and finance. The shift in the world order emphasises the importance of integrating advanced technologies into national economies to secure a strong international position. By focusing on talent, knowledge, technology and capital, smaller countries can gain a competitive advantage in this evolving landscape. Unlike the past 500 years which were dominated by capital, the current era prioritises talent in order to drive innovation and economic growth. Singapore serves as a prime example of how leveraging the combination of talent, knowledge, technology and capital can propel a country to global leadership status. Other countries such as South Korea, the United Arab Emirates and China have also thrived by adopting similar strategies. Hungary, situated as a multi-hub in the Central and Eastern European region, has the potential to excel by capitalising on its resources and location to foster cooperation between Europe and Asia in the future.

Beginning with a study by colleagues from the Research Department of Macroeconomics, the Development Research Center of the State Council of China, the first chapter explores sustainable growth. The purpose of this study is to provide readers with a better understanding of China's strategies for sustainable growth. The global economy is undergoing a turbulent transformation with slow recovery, requiring a global commitment to sustainable development and international cooperation. China has prioritised sustainable growth since 1994, with emphasis on new development concepts for high-quality development. Actions in innovation, green growth, social equity and coordinated development have shown positive results. China benefits from its economies of scale, industry chains, comparative advantages and urban clusters. However, challenges such as climate change, trade

protectionism, geopolitical instability and the shift in the domestic economy remain. China is taking steps such as promoting carbon neutrality, income distribution and cooperation with Eurasian countries to continue its path towards sustainable growth.

The next study was written by Antoine Bakewell and Paul Champey, Sustainable Finance Specialists at the Banque de France and Members of the Network for Greening the Financial System Secretariat. The authors elaborate on how economies in Europe and Asia can learn important lessons from the efforts of the Network for Greening the Financial System (NGFS) on the advancement of climate initiatives by central banks and supervisors. The NGFS has created climate macro-financial scenarios to assist supervisors and financial actors in recognising, evaluating and managing climate and environmental risks. By applying the NGFS Scenarios, financial institutions and supervisors can accurately assess the risks related to climate change's transition and physical impacts. The research indicates that shifting towards a net-zero economy is not only achievable, but also beneficial for European and Asian nations, providing significant economic advantages and reducing the effects of climate change. The paper underscores the significance of strategic planning and global cooperation in fostering climate resilience and sustainable development in Europe and Asia, as well as other regions of the global economy.

In the next study, Dr Csaba Kandrács, Deputy Governor of the MNB for the Supervision of Financial Institutions and Consumer Protection, and Norbert Holczinger, Head of the Sustainable Finance Department of the MNB, present an overview of the influence of the Magyar Nemzeti Bank's green mandate on sustainable growth. The interconnection between the natural environment, the economy and the financial system means that financial actors must engage with the management of environmental risks and the financing opportunities presented by the green transition. Central banks should also participate in this

process, even though their levels of commitment to sustainability vary globally. The MNB stands out as one of the most proactive central banks in relation to sustainability, largely due to its green mandate established in 2021, making it one of the pioneers in Europe. The primary goals of the initiatives introduced under the Green Programme, which was initiated in 2019 with an emphasis on financial stability, and the Green Monetary Policy Toolkit Strategy announced in 2021, are to facilitate the green transition and enhance the green financing landscape, which is crucial for decarbonisation and sustainable growth.

The last study in the first chapter discusses sustainable development policies that encompass economic, social and environmental aspects. It was written by Seck Tan, Associate Professor at Singapore Institute of Technology. Economic growth improves economic performance by utilising natural resources, while economic development enhances quality of life through education and employment. For development to achieve genuine sustainability, it is essential that growth be inclusive and that there be a balanced emphasis on economy, society and environment. There is a need to view the environment as a form of capital in macroeconomic modelling to ensure sustainability. Island states encounter developmental challenges stemming from their limited endowments, necessitating an emphasis on human capital to foster growth. Additionally, development policies must thoughtfully assess the effective use of the employable labour force.

The volume's second chapter shifts to the subject of competitiveness and begins with a paper by Dr Bruno Lanvin, President of the Smart City Observatory, IMD. Cities are crucial for the future, especially in the face of current challenges such as pandemics, financial crises and geopolitical tensions. As we move into a post-globalisation era, cities are stepping up to address issues left behind by nation states. By embracing new roles and innovative solutions, cities are preparing for the future and reshaping the international landscape. The paper highlights

how certain, city-specific strategies are outpacing those of their respective nation states in areas such as health, the environment, investment, innovation and talent. Cities including Budapest, Shanghai and Singapore are leading the way, showcasing how they are attracting investment and talent while promoting green and digital initiatives. The key message is that cities are the driving force behind a post-globalised world, and they must continue to take on a central role in shaping a sustainable and prosperous future.

The strengths and challenges of South Korean competitiveness are discussed by Taehyoung Cho, Director General, and Daeyup Lee, Economist, both of the Economic Research Institute at the Bank of Korea. Their paper analyses South Korea's competitive edge by assessing its resilience and ability to adapt to challenges, its investment in education and a well-educated workforce, its accumulated capital alongside a robust manufacturing base, its swift progress in digital transformation, its openness and cooperative foreign relations, as well as the realisation of South Korea's soft power potential. Challenges include demographic change and population decline, reducing economic 'dualism,' capitalising on artificial intelligence and green transition, adapting to global economic shifts, and fostering entrepreneurship. Stability in the macroeconomy is crucial for growth, necessitating the mitigation of uncertainty and building trust.

The next research contribution is a paper by Christian Ketels, Senior Advisor to the House of Governance and Public Policy at the Stockholm School of Economics. The main question of the study is: How can India realise its potential? India is frequently regarded as a nation poised for future success. While the immense potential of the country is widely acknowledged, its inherent complexities have consistently posed significant obstacles to realising this potential. The study builds upon the *Roadmap for Better Growth – India@100*, focusing on the key areas that India should prioritise to unlock its capabilities. The roadmap is shaped

by an assessment of India's current competitive landscape, highlighting both its advantages and shortcomings. Analysing these various aspects of India is beneficial for two primary reasons: Firstly, India is set to assume a more prominent role in the global economy, making it essential to comprehend its developmental trajectory for future global insights. Secondly, the challenges confronting India are also faced by numerous other developing countries. Investigating India's strategies to tackle these challenges will provide valuable insights for these countries as well.

Gergely Baksay, Executive Director of the MNB, together with his colleagues András Balatoni, Ádám Martonosi, Ágnes Nagy, András Zsolt Szabics and Ákos Szalai, cooperated on the second chapter's final study, which examines the topic of sustainable GDP. The notion of sustainable economic growth cannot be realised without a sufficient degree of competitiveness. The concepts of competitiveness and long-term sustainability are intricately linked, as only those practices that are sustainable in the long run can maintain competitiveness in the realm of socio-economic development. An effective measurement framework is essential to assess sustainability and competitiveness. While GDP is useful for traditional sectors, it falls short in measuring newer technologies, such as free digital services and cross-border activities. The Magyar Nemzeti Bank's 2024 *Sustainable GDP – Global Discussion Paper* aims to combine the measurement of economic development and sustainability.

The third chapter focuses on the topics of innovation and technology. The first study, entitled 'Instant Payment Systems in Asia,' was prepared by Levente Horváth, PhD, Director of the Eurasia Center at the John von Neumann University. The implementation of instant payment systems throughout Asia has fundamentally transformed financial transactions, providing unmatched speed, accessibility and efficiency. Countries such as Japan, South Korea and China were early pioneers of this trend in the early 2010s, which subsequently led to widespread

adoption across the continent by the late 2010s. Notable systems such as Thailand's PromptPay and Singapore's PayNow have established standards for real-time payment effectiveness. Additionally, cooperative initiatives aimed at connecting systems across Southeast Asia are designed to enable smooth cross-border payments, thereby promoting regional economic integration. The study investigates the evolution and influence of these systems in significant areas of Asia. The results highlight the transformative capacity of instant payment systems in advancing digital economies and enhancing financial inclusivity.

The second paper was written by Professor Ernesto Damiani, Dean of the College of Computing and Mathematical Sciences, and Sir John O'Reilly, President, both of the Khalifa University of Science and Technology. The study argues that digitalisation is becoming more prevalent across all sectors of the economy and society, and we are currently witnessing the rise of a new wave, significantly influenced by the extensive implementation of artificial intelligence models, particularly those that utilise supervised learning techniques. Access to these models is becoming more widespread, but in order to ensure sustainable growth we must integrate sustainability into the models' cost function. While a particular source of friction relates to control over the information needed to train and update such models, small footprint, agile models can support the frictionless deployment needed for sustainable growth. The study initially emphasises various technological developments and opportunities that will allow us to fully harness the advantages of widespread new-wave digitalisation in our pursuit of sustainable economic growth. Subsequently, the paper also identifies a concealed risk, namely the potential erosion of digital sovereignty, and presents a strategy to mitigate this issue.

The next study was authored by Gang Fan, President of China Development Institute, and Zhongxiong Cao, Assistant President, and Director of the Digital Economy and Global Strategy

Research Department of China Development Institute. Their paper outlines the elements contributing to the innovation-based economic growth of Shenzhen, which has rapidly transformed from a small fishing village into a global innovation hub in just 45 years. Home to major companies such as Huawei and Tencent, the city also fosters a growing ecosystem of startups in fields including biotechnology and artificial intelligence. Shenzhen's pillar industries have evolved from outsourced processing and export-oriented manufacturing to high-tech and strategic emerging industries. The city emphasises the integration of new and traditional growth drivers, with a focus on sustainable and green development. Shenzhen's public transportation system is powered by new energy vehicles, making it a leader in eco-friendly initiatives. The city's inclusive and open innovation environment attracts global talent, while its market mechanism supports the growth of private enterprises. The government of Shenzhen actively supports industry and innovation by creating a conducive policy framework and fostering a service-oriented approach. Shenzhen's blend of global and Chinese characteristics has made it a hub of scientific discovery and technological innovation.

The final study in the volume is a joint paper of Aigul Kussaliyeva, former Director of Sustainable Development at the Astana International Financial Centre Authority, and Ainur Zhakupova, Senior Manager of Sustainable Development at the Astana International Financial Centre Authority. The study explores the cutting-edge technologies supporting sustainable finance in Central Asia. Despite contributing only about 1% to global greenhouse gas emissions, Central Asian countries are highly vulnerable to climate change, with glaciers shrinking and water flow reduced. This impacts the agriculture sector crucial for their economies and food security. These countries are committed to international agreements to reduce emissions and are implementing strategies for carbon neutrality and green economies. However, financial resources are needed, posing

challenges to government budgets. It is crucial to secure funding for initiatives addressing climate change as well as other green and sustainable projects. The global adoption of innovative financial instruments that prioritise sustainability, including green bonds, social bonds and sustainable development bonds, is rapidly increasing, thereby fostering a strong market for sustainable finance. To attract investments in sustainable projects, Central Asian countries must strengthen their sustainable finance markets, with a focus on standardisation, assessment, capacity building and prioritisation.

We hope that these summaries shed some light on the intriguing content featured in this volume, contributing to the enhancement of current discussions and the formation of future dialogues in the professional and public domains. We are confident that this publication will help expand the resources related to Eurasian issues and support the evolution of the emerging Eurasian era.

Budapest, November 2024

Talent, Knowledge, Technology and Capital as Sources of Strategic Competitive Advantage

Marcell Horváth – Zsófia Gulyás – Dávid Szabó

The 21st century saw the beginning of the era of Eurasia, in which China – as a new great power – has become a challenger to the United States in the world economy and in the international monetary and payments system. The changing world order is creating a power struggle, in which technology and the successful integration of advanced technologies into the national economy is a crucial aspect of obtaining the best possible position on the international stage. Smaller countries also have the potential to develop a strategic competitive advantage if they base their development and growth on the four pillars of talent, knowledge, technology and capital (the '4T model,' based on the Hungarian words 'tehetség,' 'tudás,' 'technológia' and *'tőke'). Whereas in the Atlantic era, which spanned the last 500 years, the driver of the four success factors was capital, entering the Eurasian era, it is talent that drives knowledge, capital and the development and incorporation of technology into the economy. The future is likely to see an even stronger focus on talent, especially given the current rise of artificial intelligence (AI), robotics and other advanced technologies.*

The rise of Singapore in just a few decades clearly illustrates how a small, resource-poor country can become a global leader by successfully applying the 4T model and adapting to new global megatrends and

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challenges. The city-state, with its favourable geographical location, functions as a gateway and serves as a multi-hub thanks to the Strait of Malacca, which connects the Indian Ocean to the Pacific Ocean. Singapore's development model has now also become a model for South Korea, the United Arab Emirates and China. These countries, like Singapore, have developed enormously in a relatively short period of time and have become major global economies, able to compete with their Western rivals even in respect of the financial revolution that is strongly shaping geopolitics. China is the world leader in the development and research of central bank digital currency, but South Korea, the United Arab Emirates and Kazakhstan also have strong strategies in this field.

The shifting power environment offers great opportunities for Hungary, which – like Singapore – has a small, open economy, if the country builds its rise on a combination of talent, knowledge, technology and capital. Hungary, as a multi-hub in the Central and Eastern European region, occupies a strategic position between the West and the East, and could play a key role in providing connectivity and a platform for cooperation between Europe and Asia in the future.

Journal of Economic Literature (JEL) codes: E30, E32, F50, F51, I20, J10, N10, N30, N40

Keywords: the era of Eurasia, hegemonic cycles, international stability, Kondratiev cycles, talent, knowledge, technology and capital, global megatrends, Singapore

1 Introduction

With the 21st century comes the dawn of the Eurasian era, marking the end of 500 years of the Atlantic era, which has been accompanied by an increased fragmentation of the world order from the 2020s onwards, in the form of international events such as the US–China trade and technology war, the Russian–Ukrainian war and the war between Israel and Hamas. The era is marked by the rise of China, which – despite the official position that it

does not aspire to global hegemony – has become an unavoidable player and challenger to the United States in the world economy and in the international monetary and payments system. The significance of this Asian superpower is further underlined by its recent emergence as an advocate of the Global South vis-à-vis the countries of the Global North and its mission to ensure that the countries of the Global South can assert their interests in the global political arena in a manner commensurate with their increased economic weight. To achieve this, China is seeking to reform global governance and is giving priority to multilateral forms of cooperation within individual international organisations and platforms. According to the official narrative, the multipolar world order promoted by China is based on win-win partnerships through globalisation and connectivity, which benefit smaller, open economies as well, in contrast to the economic consequences of amalgamation.

With China's economic and scientific rise and the rapid growth of its high-tech industries, Western countries – led by the United States – have felt an increasing threat affecting their high-tech industries. Under the Obama administration, the US already repeatedly tried to block Chinese companies from investing in the US semiconductor industry and restricted China's access to US technology. However, tensions between the two superpowers only escalated after the inauguration of US President Donald Trump, and trade disputes and technical rivalries between the two countries became constant from 2017 onwards (Sun, 2019). In recent years, the United States has taken a number of measures to restrict China's access to strategic technologies, citing national security concerns, in response to which China has imposed export and investment restrictions on US companies. While both countries are seeking to strengthen their capabilities in critical technologies such as semiconductors, other international actors – including EU countries – are also turning to industrial policy in the shadow of the disruption of global supply chains (Bradford, 2023). The decoupling of Western and Chinese supply chains is leading

to permanent price increases due to the government spending and subsidies needed to develop alternative industries. The future relationship between the two countries is therefore crucial for both the global political and economic status quo. The struggle for technological advantage suggests that new technologies will transform the world in the 2020s, just as they did in the 1940s (Matolcsy, 2022).

It is technology and the emerging powers, and the struggle for technological advantage itself, that is the driving force behind the new digital money revolution which is occurring in parallel with the geopolitical changes of the 21st century. According to the Governor of the Magyar Nemzeti Bank, György Matolcsy (2020), the fusion of geopolitics, money and technology is now supporting a shift in the world economic and political axis towards the East, in addition to the emergence of a multipolar or even bipolar system (Boros & Kolozsi, 2019). The next milestone in rivalry between the US and China may be the central bank digital currency (CBDC). China is a world leader in CBDC research and development, and several representatives of the Global South – such as India and the member states of the Association of Southeast Asian Nations (ASEAN) – are strengthening the ranks of emerging powers, contributing to the transition from a unipolar to a multipolar world order. The rise of regionalism is accompanied by a more rigid application of the system of alliances, and a strong effort is being made to strengthen Atlanticism, alongside protectionist moves to counterbalance increasing Eurasian cooperation.

In a recent study, Anni Norring, Chief Economist at the Bank of Finland, warned that geo-economic fragmentation could become more pronounced in the future, while developments such as tensions between the US and China, Russia's invasion of Ukraine and growing differences between developed countries and the Global South threaten the interconnectedness of the world's economies (Norring, 2024).

2 The political and economic cycles of global power realignment

The international order is the actual balance of power achieved by individual international actors as a result of a power contest, with many factors playing a role in its creation. In addition to population, territory, natural resources, the size of the economy, military strength, political stability and soft power, geographical location is also a key determinant of a state's strategic position. However, these favourable endowments 'merely' provide the basis for competitive advantage, since – in particular after the commercial and scientific revolutions – the successful integration of technology and advanced technologies into the national economy is a crucial element in gaining a more advantageous position on the international stage (China Institutes of Contemporary International Relations, 2021).

Social scientists and economists have long focused on the possibility that global political and economic processes follow patterns that have been established over centuries, setting the stage for cyclical changes in the global balance of power. Some researchers have attempted to explain the dynamics of the international arena through political cycle theories, while others have tried to do so through economic cycle theories, but it is worth considering both aspects to obtain a comprehensive picture. According to George Modelski, who explains the rise and fall of great powers with the politically focused theory of hegemonic cycles, global powers have alternated in five long cycles in the 500 years or so since the discovery of the Americas in 1492. Over the 80- to 100-year great power cycles, different hegemons have ensured international stability by setting the rules of the international system. It is important to point out that, according to Modelski, world powers are always dominant maritime powers, even if they are not the strongest military nations (Rosecrance, 1987). With the beginning of the Atlantic era, Portugal was the

first to become a world power, followed by the Dutch, the two British cycles and finally the American cycle. The reigning great power inevitably lost its political legitimacy after a certain period of time, and the next rising great power appeared in parallel with its decline (Table 1) (Modelski, 1987; Boros & Kolozsi, 2019).

Table 1. Modelski's explanation of long cycles in global politics

Sections			
Global war/major war	World power	Loss of legitimacy	Decline - challenger
Portuguese cycle			
1494-1516 War in Italy and the Indian Ocean	1516-1539 Portugal	1540-1560	1560-1580 Spain
Dutch cycle			
1580-1609 Struggles for independence in the Low Countries	1609-1639 Netherlands	1640-1660	1660-1688 France
First British cycle			
1688-1713 Wars of Louis XIV	1714-1939 Britain I-II	1740-1763	1764-1792 France
Second British cycle			
1792-1815 French Revolution and Napoleonic Wars	1714-1939 Britain I-II	1850-1873	1874-1914 Germany
American cycle			
1914-1945 The First and Second World Wars	1945-1973 United States	1973-2000	2000-2030 Soviet Union

Source: Own compilation based on Modelski (1987) and Boros & Kolozsi (2019)

The book, *Leading Sectors and World Powers: The Coevolution of Global Economics and Politics* by George Modelski and William R. Thompson (1996), draws a parallel between Modelski's model of long cycles and the Kondratiev cycles that underlie economic-focused cycle theories. Developed by Nikolai Dmitriyevich Kondratiev and published in 1935, *The Long Waves in Economic Life* defines successive economic cycles based on 30- to 70-year

technological cycles (Kondratiev, 1935). According to Kondratiev, the rapid development of technology is accompanied by the clustering, diffusion and fading out of new inventions, which is behind each cycle change (Boros & Kolozsi, 2019). In their 1996 work, Modelski and Thompson argue that the successive booms and busts of the leading sectors of the world economy can be synchronised with the rise and decline of world powers in such a way that a hegemonic cycle is associated with two Kondratiev waves organised around innovative sectors of world trade and industry (Modelski & Thompson, 1996).

Technological revolutions thus upset the economic balance of power and trigger a transition of power, a geopolitical turning point in the international system. The generally accepted explanation is that the countries which emerge as winners from the power shift are those that are able to use innovation[1] to monopolise and profit from new, fast-growing industries centred around major technological breakthroughs (Ding, 2021).

3 The 4T model as a basis for economic growth and development

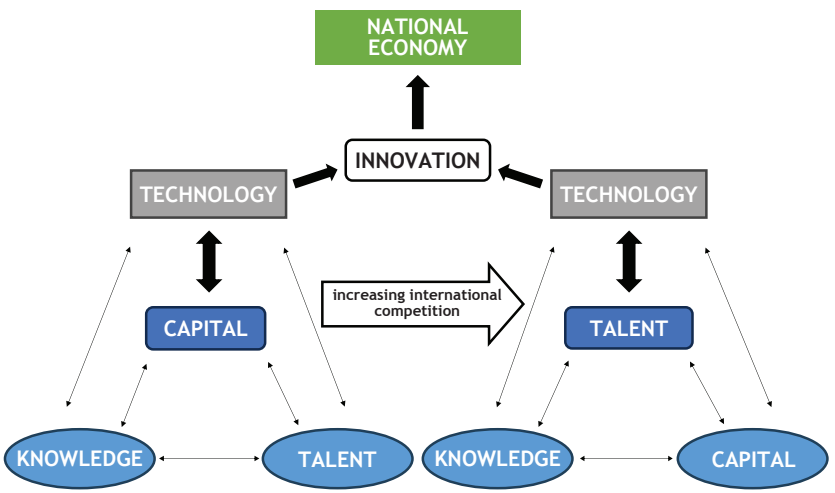
3.1 Introducing the 4T model

States that are not in the global vanguard in terms of relatively stable endowments such as population, territory, natural resources, the size of the economy, military strength or geographical location, start with a significant disadvantage in the power contest. The mechanism of action of the power transition process of technological revolutions discussed in the previous section, however, is not only a basis for countries with favourable

[1] Innovation is the application of a (new) technology to improve an existing process (MIT ID Innovation, 2022).

endowments to assert themselves more effectively in a changing power environment. It is also possible for countries with more modest capabilities to develop a strategic competitive advantage if they focus on integrating advanced technologies into their national economies as efficiently as possible. In this interpretation, the aim is the development and use of technology (its incorporation into the national economy), while the means are talent, knowledge and capital. Talent, knowledge, technology and capital are the four elements of the 4T model (based on the Hungarian words 'tehetség,' 'tudás,' 'technológia' and 'tőke') created by György Matolcsy, Governor of the central bank of Hungary, which, with the right national strategy, can ensure the global success of a given country (Figure 1) (Matolcsy, 2021). In the strategy required for success, technology and capital provide the framework, supported by talent and knowledge which provide the content.

Figure 1. The 4T model



Source: Own compilation based on Matolcsy (2021)

The elements of the 4T model are interdependent, and thus the development of one factor stimulates the development of the other three. However, whereas in the last 500 years the driver of the four

success factors was in fact capital, as we move gradually from the Atlantic era into the Eurasian era, it is talent that is driving knowledge, capital and, directly and indirectly, the development and incorporation of technology into the national economy. The primary reason for this is that in today's rapidly changing environment, international competition is intensifying in all areas, putting great pressure on international players. The role of capital remains key, but its importance has now gradually been overtaken by talent.[2] This process was triggered by the increasing value of intangible assets and the role of intellectual capital in economic life, as well as by the intensification of economic competition (globalisation) and the advance of information technology (internet) (Saxné Andor, 2014). Klaus Schwab, founder and former president of the World Economic Forum, also argues that talent, rather than capital, will become the critical factor of production in the global economy, especially in light of the ongoing fourth industrial revolution, characterised by the rise of artificial intelligence (AI), robotics and other advanced technologies (Hardman, 2023).

3.1.1 Technology

In the 21st century, new technological waves are shaping the global economy, creating new industries and transforming existing ones. Today, economic growth is inextricably linked to the requirement of sustainability and relies on two pillars: technological progress and, through it, productivity growth. A country is more likely to emerge on the international stage if at least a narrow segment of its economy is able to exploit the potential of increasing returns over a longer period of time through the continuous channelling of technology and the adaptation of innovations. This is hampered by increased competition in the market, but in an era of economic globalisation and government regulations

[2] It is important to note that the finding may change depending on the level of development of the countries. Talent is less powerful than capital in developing economies (Martin & Moldoveanu, 2003).

that restrict monopoly power and support competition, only new and truly revolutionary products or services can assist in gaining temporary market dominance. The role of consumers is also important for the success of innovative firms – and for the success of the growing returns segment of the economy as a whole – and it is important that the social embeddedness of openness to innovation is stable (Rogers, 2003; Martonosi, 2022). Waves of technological revolutions are affecting sectors based on renewable energy: the electric car industry, the longevity industry, the environmental industry based on green transition and sustainable technologies, industries using artificial intelligence, such as the defence industry, digitalisation and the service sector offering leisure activities extended to virtual space (Matolcsy, 2021).

The most technologically advanced countries in these sectors are those that are at the forefront of the world. A striking testament to China's rise is the fact that the Asian powerhouse now has considerable innovation potential. According to the Australian Strategic Policy Institute (ASPI), China's global advantage currently spans 53 of the 64 technologies tracked by the institute, and covers a number of key technology areas, including defence, space research, robotics, energy, environment, biotechnology, artificial intelligence, advanced materials and key quantum technology areas. China has thus laid the foundations for positioning itself as the world's leading scientific and technological power (Australian Strategic Policy Institute, 2023a). China has also become a major player in key sustainability industries, leading the way in solar PV production, new energy vehicles (NEV) and wind power generation. The emerging hydrogen industry, including the development of green hydrogen using electricity from renewable sources, which is the most sustainable, could also provide China with many opportunities in the future.

ASPI's *Critical Technology Tracker* has collected and analysed 10% of the most cited papers (2.4 million publications between 2018 and 2022) to show which countries publish the most high-quality

and innovative papers in critical technology and defence fields. In addition to the clear dominance of China and the US, the three Asian countries that appear most often in the rankings for each region are India, South Korea and Japan, with Iran, Pakistan, Saudi Arabia, Singapore, Taiwan and Turkey also appearing frequently in the rankings (Australian Strategic Policy Institute, 2023b).

Japan owes its global competitiveness in part to its prominent companies in automation and robotics – Panasonic, Sony, Toyota, Honda – as does South Korea with several technological pioneers (LG, Hyundai, Samsung). The US tech industry accounts for 37% of the total global market and is home to companies such as Apple, Microsoft, Facebook and Google. Also among the most technologically advanced companies is Singapore, which was among the first in the world to start producing self-driving cars and is home to some of the most advanced biomedical research institutes, such as the Genome Institute of Singapore (GeeksforGeeks, 2024).

It is also worth highlighting the United Arab Emirates, which has turned towards digitalisation and sustainable technologies in addition to developing tourism as part of its economic diversification. The country's tourism strategy up to 2031 aims to overcome international challenges by expanding the tourism sector (Stolz et al., 2023). The United Arab Emirates' government's Government Development & the Future Office,[3] and the Ministry of Possibilities,[4] a virtual ministry, both reflect the future-oriented approach of the UAE leadership.

According to the IMD *World Competitiveness Ranking 2024*, which ranks 67 countries, the top 10 most competitive countries are

[3] For more information on the Government Development & the Future Office, please visit the https://gdf.gov.ae/en/about-us website.

[4] For more information about the Ministry of Possibilities, please visit the https://mop.gov.ae/ website.

Singapore (1st), Switzerland (2nd), Hong Kong (5th), the United Arab Emirates (7th) and Taiwan (8th). The US ranked 12th, China 14th and South Korea 20th. These countries also ranked highly in the latest 2023 *Global Innovation Index* (GII) published annually by the World Intellectual Property Organization (WIPO). Globally, Switzerland ranked 1st, the USA 3rd, Singapore 5th, South Korea 10th, China 12th, Hong Kong 17th and the United Arab Emirates 32nd. This clearly shows that the ability of countries to make the most efficient use of technological innovation is more important for competitiveness than the size of the economy. The number of patents filed also gives an indication of which countries or regions are at the forefront of technological innovation. In 2022, the 5 countries/regions with the highest number of patent applications – China (46.8%), the US (17.2%), Japan (8.4%), South Korea (6.9%) and Europe (5.6%) – accounted for 84.9% of all patent applications. While China had 2.1% more patent applications in 2022 than a year earlier, the US had only 0.5% more. Europe produced the largest increase of 2.6% among the top 5 countries/regions (World Intellectual Property Organization, 2023).

3.1.2 Talent

The education system plays a vital role in nurturing creativity in young people and in exploring, identifying and developing talent for all, but in the 21st century, this is no longer sufficient. A really well-functioning education system is able to plant the seeds of the need for lifelong learning and self-education in young people, thus increasing the flexibility and adaptability of society as a whole in a world that is changing at an ever-faster pace. Training workers and unleashing their talent has a significant indirect impact on economic growth through productivity. Countries that offer comprehensive and rapid solutions to the rapidly changing challenges of the 21st century through effective education systems will be the major winners in the period ahead (Asztalos, 2022). The moral and financial appreciation of the staff of nurseries, kindergartens, primary and secondary schools is of the utmost importance, as their work in talent management is irreplaceable.

Transforming the structure and strategy of government to prioritise the role of talent can contribute to enhancing national talent attraction and retention (Matolcsy, 2021).

Countries with small but open and innovative economies, which can be the 'big winners' of the future thanks to their competitiveness, serve not only as intellectual and innovation hubs but also as transport hubs. Their world-class education builds on the best universities, and they place great emphasis on identifying and nurturing talent from an early age. The quality of their education, including labour markets and supportive innovation environments, make these countries a magnet for talent (Csizmadia, 2021). The *Global Talent Competitiveness Index* (GTCI), published annually by INSEAD and its partner institutions, assesses the ability of individual countries to harness talent and, through this, their potential for economic growth. According to the GTCI 2023, the top countries in terms of technology and innovation are also among the global leaders in terms of talent. Switzerland is ranked 1st, Singapore 2nd, the US 3rd, the UAE 22nd and South Korea 24th. Although China is only 40th in the ranking, it is ranked first among the upper middle-income countries. According to the GTCI, talent competitiveness consists of six pillars:

1. providing the right background and environment *(enable)*;
2. talent attraction *(attract)*;
3. unfolding *(grow)*;
4. retaining *(retain)*;
5. professional and technical talents *(vocational and technical skills)*; and
6. global talent for knowledge *(global knowledge skills)* (Lanvin & Monteiro, 2023).

3.1.3 Knowledge

While material goods, which once primarily determined the functioning of the economy, decrease as they are used, knowledge is an economic resource that can grow exponentially as it is shared, i.e. used. A knowledge-based economy that enables sustainable economic growth is therefore not constrained by scarce resources, but is generally characterised by abundance, with ever-expanding knowledge underpinning the development of technological revolutions. However, there are also limits to the growth of knowledge, as the time and energy invested in acquiring knowledge and learning is a limited resource, just as the available talent, creativity and diligence are not inexhaustible; all of these factors determine the quality and quantity of the knowledge acquired. All nations have the skills and factors needed to acquire knowledge, but are able to harness these in the form of economic growth to varying degrees (Asztalos, 2022). The creation of a new knowledge infrastructure that allows knowledge to be put in the public domain and fully accessible to citizens free of charge can contribute to success. In addition, universal access to the internet and lifelong learning opportunities would be a big step forward. A comprehensive reform of the public and higher education system is needed to increase competitiveness, with a particular focus on the institutions' medium- and long-term visions and strategies, and on boosting international relations and cooperation (Matolcsy, 2021). According to the *Global Knowledge Index 2023*, which supports global knowledge transfer and development, Switzerland, Finland, Sweden, the Netherlands and the US are currently the most successful and competitive in this area. These five countries, which are also among the world leaders in terms of their economies, lead the 2023 rankings for pre-university education, technical and vocational education/training, higher education, information and communication technology, research, development and innovation, and economic performance, with Singapore the first Asian country to be ranked 12th (Mohammed Bin Rashid Al Maktoum Knowledge Foundation, 2023).

Universities play a key role in transferring knowledge and nurturing talent. Although US universities still form the largest group (25) in the top 100 universities in the *QS World University Rankings 2025*, their number has decreased compared to the 2024 ranking (27). In the 2025 ranking of the top 100 universities, from the competitive Asian countries there are 5 universities from China, 2 from Singapore and 5 from South Korea, with most of them ranking higher than in the previous year. In addition, small countries that are among the global leaders in terms of competitiveness also boast excellent universities, such as Switzerland, which has 2 universities in the top 100 (QS Top Universities, 2023; QS Top Universities, 2024).

3.1.4 Capital

Capital has always been a fundamental factor of economic growth, and economic growth in the era ahead will also be capital-intensive: dynamic domestic capital accumulation, capital imports and the investment of domestic capital abroad are the three pillars of success. However, a sustained and sustainably high investment rate is a necessary, but not a sufficient condition, as the structure of investments is also a crucial factor for successful and sustained economic convergence. 'Smart' capital, such as information and communication technology (ICT), and intangible assets (e.g. research and development, computer software and databases, licences, organisational capital, know-how) are playing an increasingly important role. ICT capital and intangible capital together increase efficiency, productivity and welfare (Várnai, 2022). The majority of 'smart' investments are digitalisation investments, which, in addition to increasing competitiveness, are also beneficial for the resilience of the economy (O'Mahony et al., 2017). Effective government investment and 'outward investment' programmes, the promotion of domestic savings and business investment, and the channelling of foreign direct investment (FDI) towards capital-intensive sectors will help to further boost competitiveness. It is worth establishing technology innovation

parks around leading universities, which together provide talent, knowledge, technology and capital to investors (Matolcsy, 2021).

In terms of the opportunities for young talent, which is a pillar of economic growth, the development of the startup ecosystem is quite informative. Singapore ranked 7th, Beijing 8th, Seoul 9th and Tokyo 10th in the top 10 cities with the most significant startup ecosystem in Startup Genome's 2024 *Global Startup Ecosystem Ranking* (Startup Genome, 2024). The startup ecosystem in China has been expanding steadily in recent years, thanks in part to government support alongside startup incubators and accelerators. To stimulate innovation and help startups, the Chinese government has set up a number of organisations and programmes to promote economic development, technological innovation and job creation. Examples of such organisations and programmes include government-run investment funds and favourable tax rules (Eqvista, s.a.). Singapore also stands out for its startup support programmes, and the city-state's government plays an active role in supporting startups. The Enterprise Development Grant (EDG), Financial Sector Technology and Innovation (FSTI), Productivity and Solutions Grant (PSG), Early Stage Venture Fund (ESVF), Business Improvement Fund (BIF), Double Tax Deduction for Internationalisation (DTDi) and Market Readiness Assistance (MRA) are all government grants that help Singapore companies in various ways (Team Instarem, 2023). In addition to supporting creative startups, young entrepreneurs, post-retirement seniors and foreign talent through government initiatives (StartupBlink, 2024), South Korea also has a Ministry of SMEs and Startups, which announced a comprehensive policy called 'Startup Korea' in August 2023 to support startups in the medium and long term (Ministry of SMEs and Startups, 2023).

3.2 Global megatrends and challenges in the 21st century

In a 2011 paper, Danny Quah, Dean of the Lew Kuan Yew School of Public Policy, explained his theory of the 'migration' of the centre of gravity of the world economy, which underpins one of the most significant megatrends of our time: the geopolitical transition. According to his calculations, while in 1980 the centre of gravity of the global economy was in the mid-Atlantic, by 2008 it had drifted east of Helsinki and Bucharest. This change was triggered by the economic and demographic growth of China and East Asia as a whole, and the trend is set to continue in the coming years: by 2050, the world's economic centre of gravity is projected to be somewhere between India and China (Quah, 2011). For its economic development, Asia relies on its increasingly globally recognised universities and financial centres based on sustainable technologies, while increased connectivity through the Belt and Road Initiative (BRI) is leading to growing investment across Eurasia.

With the transformation of the global order in the 21st century and the emergence of a multipolar international order challenging the hegemony of the US, new global megatrends and challenges have emerged, and the 4T model of ensuring countries' competitiveness is key to adapting to these. The first and most important universally valid megatrend is increasing complexity: increasingly complex systems are emerging in all areas. Today, we are living in a new renaissance era based on a new balance with nature, a new humanism, a new culture based on the internet, and a new quadruple reinvention of human knowledge, with networks and transitions organised around the emerging Eurasian region. Geographic exploration has been replaced by technological research that pushes or exceeds physical boundaries, such as space exploration, the development of cyberspace, deep ocean exploration and climate regulation. The new scientific and technological revolution will bring, among other things, an era of digitalisation and robotisation, in which the rise of AI and the

reality of virtual space will open up new horizons for humanity (Matolcsy, 2023).

At the same time, new megatrends with great potential have created more complex challenges than ever before. Among the most significant challenges are global warming and the depletion of environmental resources such as water scarcity, which call for a sustainability turnaround and a rapid transition to renewable energies. Adding to the challenges is the need to identify new drivers of growth and new forms of financing in the green transition (Baksay, 2022). Many megatrends challenge humanity in their own right. The scientific and technological revolution is already causing excessive technological exposure in everyday life, and technological vulnerability will only increase in the future. The combined rise of robotisation and AI is both a challenge and an opportunity for the labour market, as it can address the growing labour shortages caused by an ageing society, in addition to expected redundancies. As digitalisation increases, cybersecurity risks are rising, highlighting a new global megatrend: the emergence of new warfare and new types of war (Matolcsy, 2023).

Harnessing the potential of new megatrends and addressing global challenges requires a holistic, multi-disciplinary approach and global cooperation among members of the members of the international community. Today, however, we are on the threshold of a new Cold War, and escalating geopolitical tensions are hampering progress (Baksay, 2022).

4. Characteristics of complex multi-hubs that successfully apply the 4T model

In the shadow of increasing global geopolitical fragmentation and rivalry, the creation of gateways, i.e. complex multi-hubs, that can serve as platforms for cooperation between the West and the East is essential. Multi-hubs are financial, logistical, technological, innovation, intellectual and knowledge hubs that make efficient use of their geography and resources in terms of knowledge and talent. Their general characteristics are:

– they have a clear vision for their future;

– they are politically and economically stable;

– they pursue knowledge-based economic policies;

– they treat innovation as a priority policy objective;

– their international financial 'embeddedness' is significant;

– they establish diversified trade links through the creation of complex connectivity; and

– they pursue a sovereign geopolitical strategy.

It is this multi-hub role that could be the key to success for small, open economies, as they can use the innovations of both blocs as platforms for cooperation between West and East, and thus rely on the 4Ts to boost their competitiveness alongside well-functioning economic policies. Such multi-hubs include the countries of Southeast Asia, in particular Singapore, the countries of Central Asia, the countries of the Persian Gulf, in particular the United Arab Emirates, and even the Central and Eastern European region, including Hungary.

4.1 Singapore, one of the world's strongest economies

Given that in the 21st century, the Atlantic era of 500 years will be followed by the Eurasian era as a result of the rise of Asia, this paper illustrates the successful application of the 4T model today with an Asian example. Singapore, with its small territory and lack of raw materials, was forced to realise early on that its national success was largely based on its intellectual capital and its excellent geographical location. Even in the current turbulent global environment, the economic development that the city-state has achieved over past decades gives Singapore a competitive edge. The importance of the city-state is further enhanced by the fact that Singapore's development model has now become a model for other countries.

In the half century since its independence in 1965, Singapore has grown from a former fishing village in the Third World to a global leader in innovation, and the small but open and developed economy is now a stronghold of global tech companies. Singapore's rise is based on the fact that the city-state's leadership has always had a clear vision for the country's future. Singapore is a great example of the success of the developmental state concept: the state – and former Prime Minister Lee Kuan Yew – has played a prominent role in the country's incredible pace of modernisation and competitiveness. The cornerstone of development since independence has been the state management of the city-state economy, based on a decades-long government strategy, stable political leadership, low corruption rates, protection of intellectual property and transparency in public institutions (EDB Singapore, 2024). Following independence, Lee Kuan Yew formed a technocratic government that led to competitive, meritocratic and results-based economic policies. In addition to becoming a maritime freight hub, Singapore's development of Changi Airport as a regional transport hub has proved to be a key step in the city-state's multi-hub development. All of this, built on a technocratic foundation of transparency and good

governance, has helped Singapore to become a hub for Asian multinationals (Hussain, 2015). To attract investors, Singapore created a safe, corruption-free and low-tax environment. The country's business-friendly laws have made it very attractive to international investors, despite its autocratic political system. Singapore's People's Action Party has been in power since 1959, and the country's future leaders are given a long time, even years, to prepare for government after they are selected. This makes Singapore a very stable state compared to politically and economically unpredictable countries, with the added advantage of its ideal location and well-developed port system. This was complemented by the promotion of free trade and the exploitation of capital inflows, so that the 'economic miracle' was based on a harmonious relationship between the public and private sectors in a country without raw materials.

In addition to a well-functioning national strategy, the 4T model also has many other elements. In the following, the paper highlights some of these and illustrates how talent, knowledge, technology and capital are playing a role in the development of Singapore's strategic competitive advantage and the city-state's emergence as a multi-hub. Given that the success of the nation requires the 4Ts to work together, consistently positive performance across all indicators is more important than excellence in any one indicator. In Singapore, this was also underpinned by the premiership of Lee Kuan Yew, who believed that for the city-state to succeed, Singapore's only available resource – its people – must be developed. A leading cultural politician of Hungary between the two world wars, Kuno Klebelsberg, who wanted to improve education at all levels and in all segments of society, held a similar view. Thanks to his activities, the quality of higher education in medicine, engineering and natural sciences in particular rose, contributing to the later scientific success of Hungarian scientists.

As Lee Kuan Yew said in a 1977 speech: "My definition of an educated person is someone who never stops learning and wants to learn." The secret of Lee Kuan Yew's nation-building strategy lies in Britain's colonial past, most evident in education. Many of the country's leading educational institutions were founded in colonial times, and the secondary curriculum is based on a British model. Although there is also a strong focus on infrastructure development, investment in education focuses on students and teachers. The country's scholarship system allows and even encourages students to study abroad, and with starting salaries above the national median, the teaching profession attracts the best graduates. Singapore's education system is meritocratic, focusing on identifying and developing the best talent, and the same meritocratic approach is applied to teacher development and promotion. Lee Kuan Yew's approach also helped to internationalise education in Singapore: as a post-colonial leader, he replaced nationalist sentiments and a majority language and culture with a global language, English, in a city-state with global ambitions (Yiannouka, 2016).

The 'talent' and 'knowledge' element of the 4T model and the role of the city-state as an intellectual and knowledge hub is reinforced by the treatment of knowledge-based economic policy and innovation as a priority policy objective. The country's expenditure on research and development (R&D) as a share of GDP is stable at around 2% (2.16% in 2022), placing Singapore in the top 20 countries in the world, ahead of Canada, Australia, the UK and Italy, among others (Dyvik, 2024). The country's talent development-focused education is outstanding in reading comprehension, mathematics and science, and the city-state usually scores well in surveys of students' different skills (FasterCapital, 2024). As a further indicator of the quality of education, two Singapore universities have been included in the *QS World University Rankings 2025*. The National University of Singapore (NUS) is the 8th best university in the world, and Nanyang Technological University (NTU) is ranked 15th, ahead

of world-class higher education institutions such as Tsinghua University (20th), Princeton University (22nd), and Yale University (23rd) (O'Callaghan, 2024). What Professor Tan Eng Chye, Rector of the National University of Singapore, said at the 2022 Budapest Eurasia Forum is a good reflection of the government-backed approach to higher education in Singapore. The professor sees universities as 'talent factories' that have an indispensable role to play in economic growth. As both the global environment and the economic landscape are undergoing increasing change, there is a constant need from the perspective of the national economy for employees to continuously develop and retrain themselves – and universities have a role to play in providing the necessary capacity to acquire new skills and to facilitate their effective use through student mobility. Singapore, as a small country, places great emphasis on developing and maintaining international links, as students who gain experience abroad become key players in the labour market when they return home.

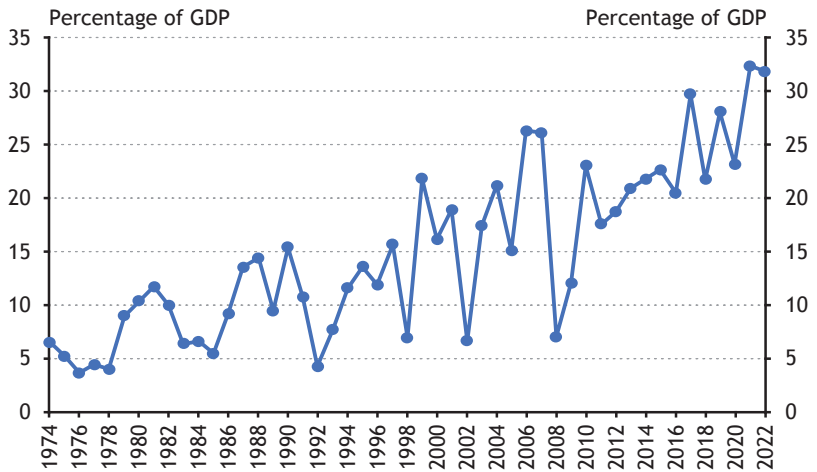
This contributes to the technology component of the 4T model and to strengthening Singapore's role as a technology and innovation hub, as the city-state is Asia's digital capital and a preferred base for ICT companies, which sees ICT investment as a source of economic and social development and a prerequisite for becoming a 'smart' nation. In 2014, the Singapore government unveiled the Smart Nation Singapore initiative, which aims to translate technological innovations into the economy and everyday life, thus improving the quality of life for Singaporeans and boosting the city-state's competitiveness. The Southeast Asian country is also supporting demand stimulation and technology adoption through its Digital Economy Framework, Digital Government Blueprint and Industry Transformation Programme (International Trade Administration, s.a.; Ministry of Trade and Industry Singapore, 2024).

Another technological aspect is that Singapore is at the forefront of global research and development in central bank digital

currency (CBDC). In November 2023, the Monetary Authority of Singapore (MAS) announced that it would launch a pilot scheme for the circulation of wholesale CBDCs in the same year (Chiang, 2023). It is also exploring retail CBDC opportunities and is involved in a number of cross-border, international bilateral and multilateral initiatives to test CBDCs. A major contribution to the city-state's financial innovation capacity is that since 2019, Singapore has been one of the hubs of the BIS Innovation Hub (BISIH), a Bank for International Settlements (BIS) project to foster technological cooperation between central banks. BISIH's Singapore centre focuses mainly on suptech, regtech, CBDC development and the development of next generation financial market infrastructures (Horváth et al., 2022). The BIS Innovation Hub is leading the Project Dunbar initiative in partnership with the Reserve Bank of Australia, the Central Bank of Malaysia, the Monetary Authority of Singapore and the South African Reserve Bank, with the MNB as an observer since 2021.

The city-state's role as a financial centre is reinforced by its significant international financial 'embeddedness'. In terms of capital, net inward FDI as a percentage of GDP has been gradually rising over the past nearly 50 years, despite some ups and downs, reaching 31.86% of GDP in 2022, according to the latest World Bank data (Figure 2) (The World Bank Group, 2024). In the ten years between 2012 and 2022, the city-state has moved up to third place in the global ranking of top FDI destinations, after the US and China. The diversified FDI inflows are illustrated by the fact that in 2023, in descending order, the United States, the Netherlands, Mainland China, Japan and Hong Kong were Singapore's top five sources of FDI, accounting for 64% of total inward FDI (Singapore Department of Statistics, 2024). In terms of outward FDI, Singapore was ranked in the top ten countries for outward FDI in both 2017 and 2019 (Nayak, 2023). FDI increases the overall productivity and competitiveness of the host economy by creating job opportunities and facilitating the transfer of knowledge and technology.

Figure 2. Net inward FDI in Singapore, as a percentage of GDP



Source: Own compilation based on data from The World Bank Group (2024)

The country's leadership has made it an explicit goal to create an economic and social environment that is ideal for foreign investors, thus attracting capital and talent. Singapore's attractiveness is based on a business-friendly environment, favourable government subsidies, a highly skilled workforce, advanced infrastructure and a diverse technology ecosystem, in the promotion of which the supporting application of AI plays a major role (EDB Singapore, 2023).

Singapore is leading the way in promoting green finance, and thus to create a sustainable and low-carbon future. To promote green investment, the Singapore government and the Monetary Authority of Singapore (MAS) regularly develop various initiatives and platforms – such as the Singapore Green Plan 2030 and the Green Finance Action Plan – that provide a framework for mobilising public and private sector efforts (Liang & Song, 2023).

Innovation is closely linked to every element of the 4T model. The World Intellectual Property Organization's (WIPO) annual *Global Innovation Index 2023* assesses the performance of 132 economies

in the innovation ecosystem, while tracking the latest global innovation trends. In the region Southeast Asia, East Asia and Oceania, Singapore was the leading innovation power in 2023, ahead of South Korea, which fell to 2nd place, and China, which ranks 3rd. In a global comparison, Singapore was the first Asian country to rank 5th in the Innovation Index, up two places from a year earlier. The country's performance is outstanding in most areas, such as institutional, regulatory and business environment, and logistics performance, where it is a world leader (Dutta et al., 2023; Dutta et al., 2022).

According to the annual IMD *World Competitiveness Ranking*, Singapore consistently ranked among the top five most competitive countries globally for the five years 2019 to 2023. In 2023, it was the 3rd most competitive country in the world in terms of economic performance, 7th in terms of government efficiency, 8th in terms of business efficiency and 9th in terms of infrastructure. The city-state has become the most competitive country in the world overall in 2024 (IMD, 2024). The *Global Talent Competitiveness Index* has consistently ranked Singapore among the best performing, most talent competitive countries globally over the past decade and the absolute leader in the Asia-Pacific region. In 2023, for the third consecutive year, it managed to maintain its second place in the comprehensive global ranking after Switzerland, ranking in the top three places in four of the six pillars of talent competitiveness at global level: 1st for 'global knowledge skills,' 2nd for 'talent attraction' and 3rd for 'growing' and 'professional and technical skills' (Lanvin & Monteiro, 2023).

According to the latest, 35th edition of the *Global Financial Centres Index* (GFCI), which is published twice annually jointly by Z/Yen Partners and the China Development Institute, Singapore is now the 3rd most competitive financial centre globally after New York and London (Wardle & Mainelli, 2024). In Asia's most competitive financial centre, the reliability of the business environment is based partly on outstanding external and internal political

stability and partly on a legal system based on Anglo-Saxon jurisprudence that helps smaller startups to access external finance (National Bureau of Economic Research, 1997). A favourable legal and regulatory environment is coupled with a transparent tax system which explicitly supports economic activities that promote gradual, sustainable growth (Horváth et al., 2022).

Singapore is a true multi-hub: as well as being a financial, technological, innovation, intellectual and knowledge hub, its favourable geographical location makes it a global transport and logistics hub, with the Straits of Malacca off its coast, one of the busiest shipping routes in the world, linking the Indian Ocean to the Pacific.

The city-state also pursues a sovereign geopolitical strategy: its neutral, balanced yet active foreign policy role makes it an important diplomatic factor on the global stage. In 2015, Singapore hosted the first face-to-face talks between the Chinese and Taiwanese leaders, and in 2018, US President Donald Trump and North Korean leader Kim Jong Un met here in an historic summit. Because of its geopolitical importance, the city-state is also known as the 'Washington of the East,' a key partner of both the US and China, both economically and militarily. Singapore plays a key role in bridging the growing divide between the West and China, albeit balancing the two represents an increasing challenge for the city-state. While the US–China standoff is escalating and there is still a serious conflict of interest between Singapore and China over the South China Sea, the city-state continues to deepen its defence ties with the US despite the increasing inflow of Chinese capital (Gulyás, 2024). Singapore is a member of the Association of Southeast Asian Nations (ASEAN), a regional grouping of ten Southeast Asian nations, and has been invited to G20 summits and related meetings for more than a decade. Complex connectivity contributes to the effectiveness of Singapore's diversified foreign policy and trade relations.

5 Conclusion and outlook

The combination of talent, knowledge, technology and capital plays a key role in shaping a country's strategic competitive advantage. Singapore is a striking example of how a small, resource-poor country can become a global leader through the successful application of the 4T model and its multi-hub role. Innovation, high value added industries and the service sector have gradually become the driving forces of development in the city-state, supporting the country on its way to building a knowledge-based economy. This required high quality education and the development of an educated society in Singapore. Education develops human capital and the skills and competences of society that contribute to economic growth. Investing in quality education has increased the efficiency, productivity, innovation and adaptability of the workforce, giving Singapore a significant competitive advantage in an ever-changing labour market in line with global megatrends (GGI Insights, 2024).

Singapore's development model is essentially the application of the 4T model with developmental state instruments, and has now become a model for countries such as South Korea, the United Arab Emirates and China. What these countries have in common is that, like Singapore, they followed a massive development path much later and in a relatively short time compared to the West. They have now become major global economies, able to compete with their Western rivals, laying the foundations for the emerging new global international order, marked by the rise of Eurasia. Talent has become the driving force behind the 4T model for the 21st century, and thus it is a significant achievement that the UAE has become the most competitive country for talent in the North Africa and West Asia region, according to the GTCI 2023 publication. South Korea is the 2nd most competitive country in the East and Southeast Asia region after Singapore, while China is the most competitive non-high-income country in terms of

talent. Although Kazakhstan (67th) is still less prominent in the ranking, it is a positive sign that, for the first time, last year's *Global Innovation Index* ranked Kazakhstan among the three most innovative economies in the Central and South Asian region in 2023 (Dutta et al., 2023).

One of the consequences of technological innovation as a competitive advantage in the great power competition is the revolution in money, which has led to the rise of financial digitalisation and the emergence of CBDCs (Baksay, 2022). Countries that actively participate in the financial revolution and successfully exploit the opportunities offered by the new horizons may gain a significant advantage in the geopolitical arena. China is a world leader in CBDC research and development, and South Korea, the UAE and Kazakhstan have strong strategies in this field. The digital tenge issued by the National Bank of Kazakhstan (NBK) is currently in the second phase of testing and is expected to be introduced by the end of 2025 (Kudrenok, 2024). Kazakhstan launched the first CBDC card in Eurasia in November 2023, in partnership with Mastercard. The card can be used anywhere in the world where Mastercard is accepted (Fedorova, 2023).

As a small, open economy, Hungary, like Singapore, should take advantage of the changing power environment to gain a more favourable position on the international stage. Adapting to global megatrends and challenges, drawing on a combination of talent, knowledge, technology and capital, is the key to development and empowerment. Just as Singapore is the gateway to Southeast Asia, Hungary is the gateway to Central and Eastern Europe, occupying a strategic position between West and East. For the country's individual ambitions and for the international community, it is of historic importance that Hungary, as a multi-HUB connecting Europe and Asia in the Eurasian era, counteracts the blockage and strengthens connectivity, complementing global initiatives and strategies such as China's Belt and Road Initiative. It would be important to achieve effective international cooperation on the

most important global challenges, replacing competition in the areas concerned with more effective cooperation, thus providing more scope for systemic cross-border application of the 4T model within Eurasia and globally.

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Chapter 1

Sustainable Growth – Various Pathways, One Common Goal

China's Strategies for Sustainable Growth

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The global economy is currently in a period of turbulent transformation and slow recovery, while the world is at a historic crossroads. Global commitment is required to advance sustainable development and strengthen international cooperation. Through relentless efforts in sustainable growth, China achieved its first centenary goal in 2021, and in 2023 China's GDP per capita reached USD 12,700. The Third Plenum of the 20th Central Committee of the Communist Party of China, held in 2024, proposed systematic measures to further comprehensively deepen reforms and promote Chinese-style modernisation, focusing on achieving sustainable growth. China's development will also bring more opportunities for win-win cooperation between China and other countries, injecting more vitality and certainty into global economic growth. Discussing China's sustainable growth strategy, actions and achievements, this article analyses the favourable conditions, internal and external challenges and ongoing actions for China to promote sustainable growth. The basic arguments are as follows. Firstly, China has always attached great importance to sustainable growth. As early as 1994, China State Council issued China's Agenda 21, which proposed the implementation of a sustainable development strategy. As the stage of economic development is elevated and practical experience is continuously gained, understanding of the meanings of China's Agenda 21 has been enriched. The 20th National Congress once again emphasised the need to completely, accurately and comprehensively implement the new development concepts, to adhere to the theme of promoting high-quality

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development and to promote substantial improvements in the quality of the economy and reasonable growth in quantity, thus providing clear guidance for China's sustainable growth. Secondly, China's actions in key areas of sustainable growth have achieved positive results. China has been accelerating innovation-driven growth and the transformation of growth drivers, continuously promoting green growth, sharing outcomes of development to enhance social equity, deepening the advancement of coordinated development to narrow urban–rural and regional gaps, and adhering to institutional openness and in-depth integration with the world. Thirdly, China has many favourable conditions for promoting sustainable growth. Currently, China is still in a phase of rapid release of total demand, with its economies of scale helping to form complete and competitive industry chains, its long-term accumulation and dynamic evolution of comparative advantages injecting continuous momentum, its scale and agglomeration effects of urban clusters significantly promoting shared prosperity and its in-depth integration with the global economic and trade network promoting sustainable growth in the world. Fourthly, China's sustainable development still faces internal and external challenges, which mainly include global climate change, trade protectionism, geopolitical instability, and the domestic economy shifting from fast-paced growth to high-quality development; strong efforts are still required to continuously promote sustainable growth. Fifthly, China is taking a series of actions to achieve sustainable growth, including developing new quality productive forces, accelerating the formation of a high-quality market economy, actively promoting carbon peak and carbon neutrality, improving income distribution, adhering to high-quality opening up and deepening cooperation with Eurasian countries, etc.

Journal of Economic Literature (JEL) codes: E00, O11, Q50

Keywords: sustainable, high-quality, growth, China

1 Introduction

At present, the global economy is still slowly recovering amidst turbulence and transformation, marked by geopolitical tensions, escalating local conflicts, the rise of protectionism and unilateralism, mounting risks of climate change, and the profound impact of cutting-edge technological advancements such as artificial intelligence on human society. The world stands at a crossroads in history, necessitating a global commitment to advancing sustainable development and strengthening international cooperation. Chinese President Xi Jinping emphasises that development is only genuine when it is shared, and only good when it is sustainable (Xi, 2020). Thanks to relentless efforts in sustainable growth, China achieved its first 'Centenary Goals' in 2021, building a moderately prosperous society in all respects and reaching a historic solution to the problem of absolute poverty. In 2023, China's GDP per capita reached USD 12,700. The Third Plenum of the 20th Central Committee of the Communist Party of China (CPC), held in 2024, proposed systematic measures to further comprehensively deepen reforms and advance Chinese-style modernisation. In the new stage of development, the challenging and complex international environment and the arduous and heavy tasks of achieving domestic reform, development and stability necessitate guidance by new development concepts, the continuous improvement of incentive and constraint mechanisms to promote high-quality development, and the incubation of new drivers and advantages for growth, to continuously drive sustainable growth.

2 Actions and achievements in sustainable growth

China has always attached great importance to sustainable growth. As early as 1994, China's State Council issued *China's Agenda 21* (State Council of the People's Republic of China, 1994), proposing the implementation of a sustainable development strategy. As the stage of economic development is elevated and practical experience is continuously accumulated, understanding of the meanings of *China's Agenda 21* has been enriched. The Fifth Plenum of the 18th Central Committee of the Communist Party of China systematically proposed the new development concepts of innovation, coordination, greening, openness and sharing. The 19th National Congress of CPC proposed for the first time that high-quality development is the primary task for building a modern socialist country in all respects. The 20th National Congress once again emphasised the need to completely, accurately and comprehensively implement the new development concepts, to adhere to the theme of promoting high-quality development and to promote substantial improvements in the quality of the economy and reasonable growth in quantity, thus further providing clear guidance for China's sustainable growth.

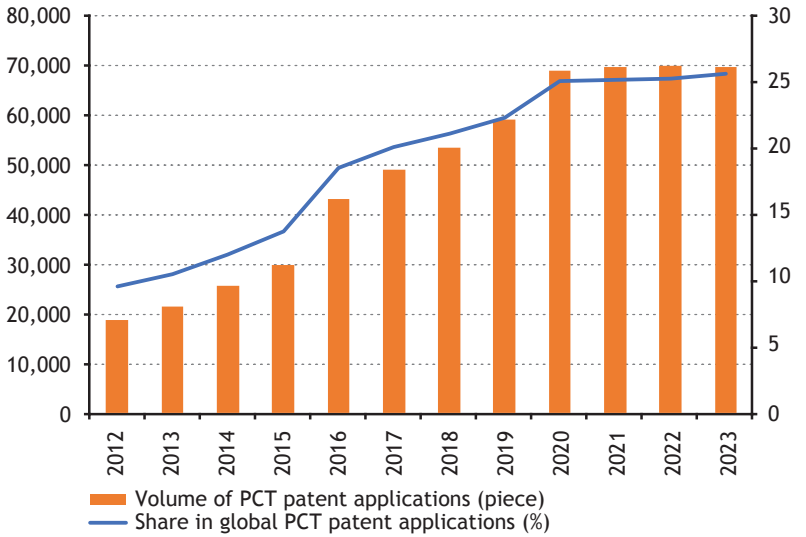
2.1 Accelerating innovation-driven growth, to transform growth drivers

In the high-speed growth stage, urbanisation and industrialisation proceeded rapidly, with ample space for the reallocation of factors. When entering into the new stage of development, seizing the opportunities of global technological and industrial transformation, realising dynamic upgrades in the structure of factor endowments and comparative advantages and fully enhancing innovation capabilities are crucial for the transformation of growth drivers. The 18th National Congress

of CPC proposed implementation of an innovation-driven development strategy. The 19th National Congress stated that innovation is the primary driver of development, and the report of the 20th National Congress pointed out that China must adhere to the principle of regarding science and technology as China's primary productive forces, talent as a primary resource and innovation as a primary growth driver.

By focusing on improving the ability to lead through innovation, the supportive role of innovation in economic growth has continuously strengthened. The number and quality of patents has continued to rise. The number of internationally recognised patents has been steadily climbing, with China's Patent Cooperation Treaty (PCT) applications amounting to 18,616 in 2012 and reaching 69,610 in 2023, ranking first in the world, with an average annual growth rate of 14.1% from 2012 to 2023. The construction of a modernised industrial system has been steadily advancing. In 2023, investment in high-tech industries increased by 10.3% year-on-year, and the value-added output of high-tech manufacturing accounted for 15.7% of the total industrial value-added output by enterprises above designated size. By the end of 2023, the Computer Numerical Control (CNC) machine tool adoption rate in key processes of industrial enterprises and the popularisation rate of digital R&D (research and development) and design tools had reached 62.2% and 79.6%, respectively. New industries, new formats and new models continue to emerge, such as online e-commerce, live streaming e-commerce, blind-box economy, the metaverse industry, instant retail and smart terminal devices, characterised by strong influence on industries, great development potential and rapid growth rates.

Figure 1. Number and growth rate of China's PCT patent applications



Source: Authors' work, based on data from the World Intellectual Property Organization (PCT Yearly Review, 2024)

2.2 Continuously promoting green growth, to foster harmonious coexistence between humans and nature

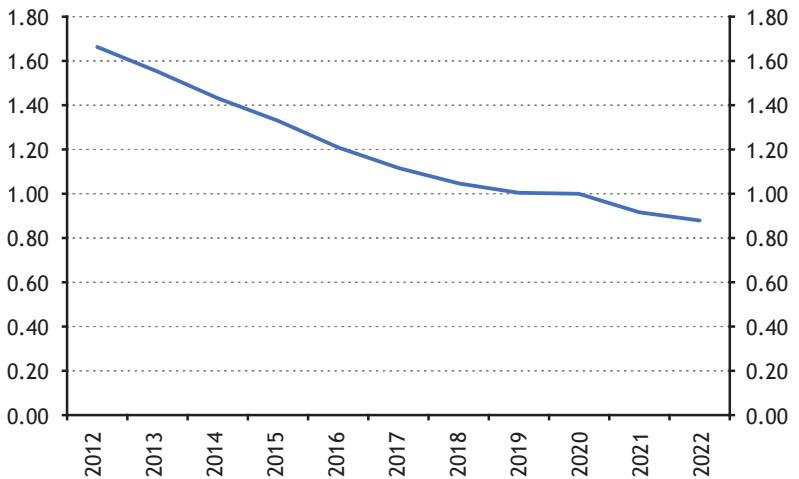
There is a symbiotic relationship between humans and nature. Promoting green growth can not only satisfy the growing demand of the people for a beautiful ecological environment, but also create new opportunities for demand and investment, generating new growth momentum. This is especially important for China, a country with a large population and tight resource constraints. President Xi Jinping pointed out as early as 2005 that 'lucid waters and lush mountains are invaluable assets' (Xi, 2022). The 18th National Congress of CPC proposed the 'ecological civilisation construction' and enshrined it in China's Constitution (National People's Congress, 2018). The 19th National Congress proposed accelerating the reform of the ecological civilisation

system. In 2021, China proposed to strive to achieve carbon peaking by 2030 and carbon neutrality by 2060. The 20th National Congress proposed to promote green development and to foster harmonious coexistence between humans and nature.

Firmly adhering to the principle of promoting green development and fostering harmonious coexistence between humans and nature, China has continuously improved its ecological environment, with the importance of green growth in economic development becoming more pronounced. The quality of the ecological environment has continued to improve. In 2014, the ratio of cities meeting air quality standards was only 9.9%, but by 2023, the proportion of days with good air quality in 339 cities at prefecture-level and above had risen to 85.5%. In 2023, out of 3,641 national surface water assessment sections, the proportion of sections with good water quality (classes I-III) was 89.4%, reflecting a 1.5% increase from the previous year. In 2023, the safe utilisation rate of contaminated cultivated land reached over 91%, and the overall environmental condition of agricultural land soil was stable. A green mode of development is gradually taking shape. Regarding consumption, in the first half of April 2024, the retail penetration rate of new energy passenger cars in China reached 50.4%, surpassing traditional fuel-powered passenger cars for the first time. Regarding investment, the balance of green loans in China's local and foreign currencies reached RMB 30.1 trillion (equivalent of USD 4.24 trillion as at December 31, 2023) by the end of 2023, a year-on-year increase of 36.5%. Regarding trade, the export value of the 'new three products' (new energy vehicles, photovoltaic products and lithium batteries) exceeded the trillion RMB (equivalent of USD 141 billion as at December 31, 2023) mark for the first time in 2023, reaching RMB 1.1 trillion (equivalent of USD 155 billion as at December 31, 2023). Progress towards the goal of carbon peaking and carbon neutrality is being steadily advanced. According to British Petroleum (BP), China's CO_2 emissions per RMB 10,000 (equivalent of USD 1,409 as at December 31, 2023) of GDP decreased from 1.7 tons in 2012 to

0.9 tons in 2022, a decrease of 47.3%. In 2023, China's renewable energy generation rounded up to 3.0 trillion kW h, surpassing the total social electricity consumption of the 27 European Union countries (China Renewable Energy Engineering Institute, 2024).

Figure 2. CO_2 emissions per RMB 10,000 (equivalent of USD 1,409 as at December 31, 2023) of GDP (metric tonnes)



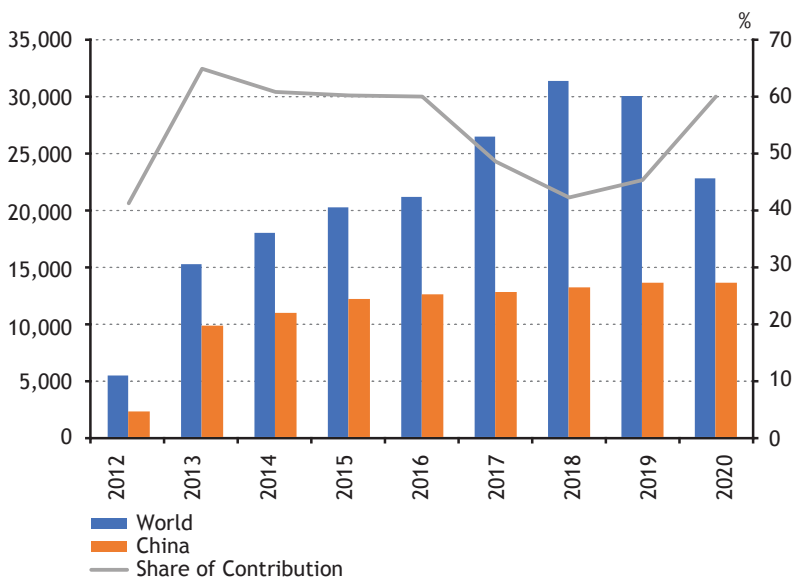
Source: Authors' work, based on data from the National Bureau of Statistics (National data, 2024)

2.3 Promoting the sharing of outcomes of development, to advance social equity

Throughout history, the balance between efficiency and equity has been a fundamental contradiction in the process of modernisation. Common prosperity is an essential requirement of socialism with Chinese characteristics, and promoting Chinese-style modernisation must also address the relationship between efficiency and equity. Since the 18th National Congress of CPC, China has placed greater emphasis on promoting shared development, so that the fruits of modernisation benefit all people more and fairly.

By adhering to and practicing the concept of shared development, social equity has improved further. The effect of poverty alleviation is significant. World Bank data show that, according to the standard of USD 2.15 per person per day, from 2012 to 2020, 230 million people worldwide escaped poverty, with China contributing the most, accounting for 59.8% (World Bank Group, 2021). Employment and income have continuously improved. From 2014 to 2023, a total of 130 million new jobs were created, and the cumulative growth rate of per capita disposable income reached 79.7%. The world's largest social security network has been built. As of the end of 2023, the number of people participating in China's basic endowment insurance reached 1.1 billion, the coverage of basic medical insurance in China remained stable above 95%.

Figure 3. Cumulative number of people lifted out of poverty from 2012 to 2020 and China's share of contribution



Note: According to the World Bank's poverty standard of USD 2.15 per person per day.
Source: Authors' work, based on data from the World Bank (World Bank Group, 2021)

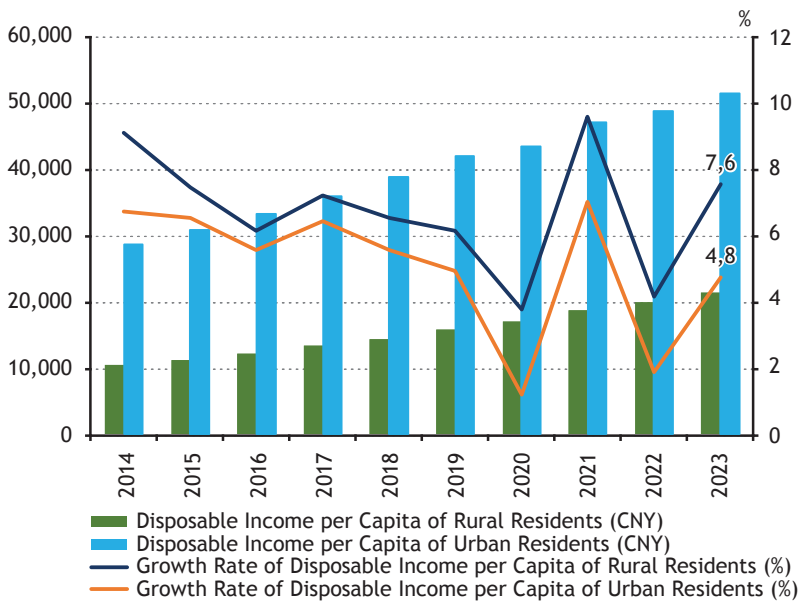
2.4 Deepening the advancement of coordinated development, to narrow urban-rural and regional gaps

China's vast territory, with varying resource endowments and development conditions, presents significant disparities between the eastern, central and western regions, as well as pronounced urban–rural gaps. China attaches great importance to regional coordinated development. The report of the 20th National Congress of CPC identified the promotion of regional coordinated development and urban–rural integrated development as crucial tasks for driving high-quality development.

By focusing on resolving unbalanced development issues, coordinated development has achieved new progress. The regional development gap has been narrowing: China has actively promoted the new chapter of opening up of the western region, the comprehensive revitalisation of the northeast, the accelerated rise of the central region and the expedited modernisation of the eastern region, leading to more balanced regional development. Disposable income per capita in the richest provinces was 4.3 times that of the poorest provinces in 2014, falling to 3.4 times in 2022. China has thoroughly implemented major regional strategies, such as the coordinated development of the Beijing–Tianjin–Hebei Region, development of Yangtze River Economic Belt, construction of the Guangdong–Hong Kong–Macao Greater Bay Area, integrated development of the Yangtze River Delta and ecological protection and high-quality development of the Yellow River Basin. The development of city clusters has been fruitful. A one-hour transportation area in the core part of the Beijing–Tianjin–Hebei Region has been basically formed. In 2023, the economic output of the Yangtze River Delta reached RMB 30.5 trillion (equivalent of USD 4.30 trillion as at December 31, 2023), close to one quarter of national GDP. The urban–rural gap has further narrowed. China has prioritised the development of agriculture and rural areas, promoted urban–rural integrated development, facilitated the flow of factors between urban and

rural areas, and comprehensively promoted rural revitalisation. From 2014 to 2023, the average annual growth rate of disposable income per capita and consumption per capita of rural residents in China were 8.4% and 9.0%, respectively, faster than those of urban residents by 1.7% and 3.3%, respectively.

Figure 4. Growth rate of disposable income per capita of rural and urban residents



Source: Authors' work, based on data from the National Bureau of Statistics (National data, 2024)

2.5 Adhering to advancing institutional openness, to further integrate with the world

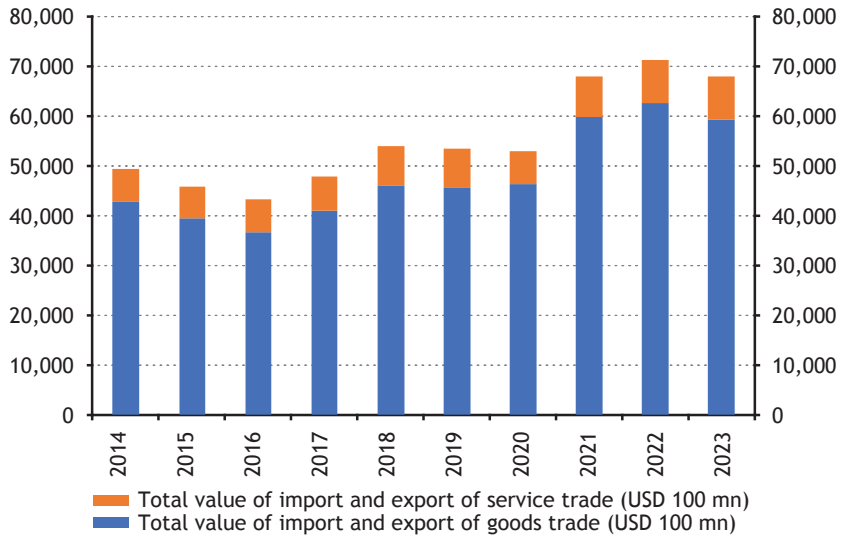
Openness to the outside world is an indispensable path for China's prosperity and development, providing a strong impetus for China to integrate into economic globalisation and achieve leapfrog development. The Third Plenum of the 11th Central Committee in 1978 marked the beginning of reform and opening-up. The 14th National Congress of CPC in 1992 established the

reform direction and goals of a socialist market economy. In 2001, China joined the World Trade Organization. In 2013, President Xi Jinping proposed the Belt and Road Initiative (BRI). The 19th National Congress of CPC called for promoting the formation of a new pattern of comprehensive opening-up. The 20th National Congress further proposed steadily expanding institutionalised opening-up and promoting high-quality opening-up.

Measures for opening up have been continuously upgraded, and China's connections with the world have become even closer. China ranks first in the world in terms of import and export trade in goods, with rapid growth in service trade and rapid development of new trade models. In 2023, China's total import and export trade in goods amounted to USD 5.9 trillion, ranking first in the world for seven consecutive years. According to statistics from the Ministry of Commerce of P.R.C., the total trade of services in 2023 reached RMB 6.6 trillion (equivalent of USD 930 billion as at December 31, 2023), showing a year-on-year increase of 10%. In 2023, the export value of cross-border e-commerce reached RMB 2.4 trillion (equivalent of USD 338 billion as at December 31, 2023), with a growth rate of 15.6%, 65 times higher than that in 2015. Both the utilisation of foreign investment and the scale of outward investment currently rank second in the world. From 2012 to 2023, China's cumulative actual use of foreign direct investment (FDI) reached USD 1.7 trillion, with an average annual growth rate of 2.8%. In 2023, China ranked second in the world in terms of inward foreign direct investment (United Nations Conference on Trade and Development, 2024). China's direct investment outflow amounted to USD 147.9 billion in 2023, ranking second in the world and reflecting an increase of 68.4% from 2012. The Belt and Road Initiative has made positive progress. In 2023, China's import and export with countries participating in BRI reached a new high, advancing to RMB 19.5 trillion (equivalent of USD 2.75 trillion as at December 31, 2023). From 2015 to 2023, China's cumulative direct investment in countries participating in BRI exceeded

USD 165.3 billion. Signature projects such as the Jakarta–Bandung High-Speed Railway, and the Silk Road E-commerce are steadily progressing, and a large number of 'small yet smart programmes' aimed at benefiting people's lives have taken root.

Figure 5. Total import and export value of China's trade



Source: Authors' work, based on data from the National Bureau of Statistics (National data, 2024)

3 Favourable conditions for China's promotion of sustainable growth

Over the past four years, against the backdrop of the headwinds faced by globalisation, the impact of the once-in-a-century pandemic and the correction of important issues affecting long-term development, China's economy has grown at an average annual rate of 4.7%. Internationally, this growth rate is higher than the average annual growth rate of 2.4% calculated by the International Monetary Fund for the global economy. The Chinese

economy continues to maintain its faster growth rate compared to the global economy. From the perspective of development stage, this growth rate is also higher than the average annual economic growth rate of 3.7% for 78 economies after their per capita GDP reached USD 10,000. In a complex and challenging environment, China has achieved good economic development results, reflecting the important foundations and advantages accumulated throughout the long-term development process of China's economy, which provide favourable conditions for the further promotion of sustainable growth.

Currently, China is still in the stage of rapid release of total demand, providing the basic conditions for sustainable growth. The scarcest resource is the market, which is a great advantage of China. Firstly, the urbanisation process holds immense potential for domestic demand. In 2023, China's urbanisation rate reached 66.2%, increasing by more than 1% annually over the past two decades. Compared to the average urban population of 81% in high-income countries, there is still significant room for improvement. Currently, China has about 250 million non-resident permanent residents who, if provided with the same public services as local citizens, will also unleash significant demand potential. At the same time, the demand for development and upgrade among local citizens is also growing. Secondly, the digital transformation is fostering new infrastructure, new businesses and new consumption. In 2023, the number of 5G base stations reached 3.4 million, 26 times of that of 2019. Revenues from emerging businesses such as data centres, cloud computing, big data and Internet of Things are growing rapidly. Online retail of goods and services has accounted for nearly one third of the social total retail sales of consumer goods. China's industrial robot installation exceeds one half of the global total. Thirdly, demand engendered by the green transformation is materialising rapidly. The energy structure, transportation structure, industrial structure and lifestyle in China are undergoing a rapid green and low-carbon transformation, nurturing a trillion-RMB (equivalent

of USD 141 billion as at December 31, 2023) green investment and consumption market. In 2023, China's installed capacity of renewable energy surpassed that of thermal power for the first time, and the production and sales volume of new energy vehicles approached 10 million units.

China's advantage in economies of scale is significant, which helps to form complete and competitive industry chains. China has continued to be the world's largest manufacturing country and the world's largest goods trade country for many years consecutively, with its advantage in economies of scale becoming even more outstanding. Firstly, the strong supportive capacity of the manufacturing industry supports various industries in forming relatively complete industry chains. China's manufacturing value-added output accounts for about 30% of the global total. The efficient and coordinated manufacturing network provides comprehensive support for the development of various industries and numerous parts of those industries; moreover, China also has formed relatively complete industry chains and supply chains. Secondly, the super-large market can amortise costs and accommodate the competition and growth of multiple technological routes. China's super-large market can help companies quickly amortise costs, providing them with sufficient number of runways for different technology innovation routes and innovative business models, and with the advantages of low cost and high performance gained in Chinese market competition, enterprises can enter the international market with strong international competitiveness (Research Group of the Development Research Center of State Council of China, 2023).

The long-term accumulation and dynamic evolution of comparative advantages have injected continuous momentum into China's economic transformation and upgrading. In recent years, China's advanced technologies have been continuously upgraded, the structure of factor endowments has undergone profound changes and the combination of digitalisation and

green transformation has strongly supported the sustained transformation and upgrading of the economy. Firstly, technological innovation capabilities have been continuously strengthened. Over the past decade, China's total social R&D investment has grown at an average annual rate of 10.9%, with the intensity of R&D investment increasing from 2.1% to 2.6%. In the Global Innovation Index released by the World Intellectual Property Organization (World Intellectual Property Organization, 2023), China's ranking has risen from 34th in 2012 to 12th in 2023. Secondly, the quality of the workforce has been continuously improving. Over the past decade, the number of college graduates in China has exceeded 80 million, and the average years of education for the currently incremental labour force is 14 years. China accounts for one quarter of the world's total population of engineers. Thirdly, the increase in capital adequacy has provided strong support for the development of technology and capital-intensive industries. By 2022, China's capital formation accounted for 28.1% of the global total, narrowing the funding shortage for industrial development. China has built a number of high-quality infrastructure assets such as railways, highways, pipelines for transportation, power grids, the internet, computing centres and charging piles, which strongly support the development of emerging industries. Fourthly, rich data resources create more opportunities for the development of emerging industries. China's digital economy ranks second globally, with digital empowerment significantly improving the manufacturing and logistics efficiency of the new energy industry, more timely response to customers and faster iterations for new product design and technologies. China's data volume is expected to grow to 76.6 ZB (zettabyte) by 2027, ranking first globally (International Data Corporation, 2023).

China's city clusters have significant scale and concentration effects, which contribute to promoting shared prosperity. Over 80% of the world's GDP is contributed by cities, and competitive cities can effectively enhance productivity and increase residents' income, which are important ways to eliminate extreme poverty

and promote shared prosperity. Firstly, China's cities have an advantage in scale. China's city clusters are growing rapidly, with the urban population in the Beijing–Tianjin–Hebei, Yangtze River Delta, Pearl River Delta, Chengdu–Chongqing, and middle reaches of the Yangtze River city clusters exceeding 460 million. In April 2021, MIT Technology Review published an article stating that China's urbanisation rate has surged from 30% to about 60% over the past two decades, a process that took Europe 90 years and the United States 60 years (Xin, 2021). Secondly, the connectivity of urban networks is strong. Well-developed intercity transportation networks have attracted various production factors to city clusters, providing China's economic growth with continuous development momentum and innovation sources. In September 2023, the British magazine International Banker published an article entitled *Connecting the World: How High-Speed Rail is Transforming Asia's Economic Potential*, noting that China has the world's longest and fastest high-speed rail network, playing a crucial role in connecting diverse communities, promoting local economies and providing new job opportunities (Larsen, 2023). Thirdly, the division of functions and coordination among cities in city clusters has reenforced industrial clusters and economic specialisation. In October 2021, the Asian Development Bank pointed out that cities within clusters compete to attract enterprises and talents, while collaborating to generate more benefits (Asian Development Bank, 2021). For example, the research and manufacturing partnerships in city clusters such as the Yangtze River Delta region and middle reaches of the Yangtze River have promoted the formation of the automotive industry cluster.

China has deeply integrated into the global economic and trade network, promoting sustainable growth in the world. Firstly, China is deeply integrated into the global economy. Currently, China's economic aggregate accounts for about one fifth of the world, making it a major trading partner for over 140 countries and regions. China has become the country with the widest global economic and trade connections, as well as one of the three major

hubs of global value chains. Secondly, China has provided the world with huge demand and stable supply. McKinsey once predicted that one quarter of global consumption growth will come from China in the next decade (McKinsey, 2021). During the Covid-19 pandemic period, China provided the world with stable commodity supply. Thirdly, the rapid development of China's new energy industry has made an important contribution to global efforts to address climate change. China has found feasible technological path for deep decarbonisation in energy and transportation sectors through its own efforts and has significantly reduced the cost of new energy products through large-scale application. From 2010 to 2022, the cost of onshore wind power generation has fallen from 95% higher than that of fossil energy power generation to 29% lower, and the cost of solar power generation has decreased from 710% higher than that of fossil energy power generation to 52% lower. The overall price of electric vehicles has also been reduced to be roughly equivalent to that of internal combustion engine vehicles, significantly reducing the cost of responding to global climate change.

4 Challenges China still faces in sustainable development

4.1 External challenges

The threat of global climate change is becoming increasingly severe. 2023 was the hottest year on record globally. Extreme weather events such as prolonged high temperatures, droughts, heavy rains and floods are becoming more frequent, causing significant impacts and severe threats to global economic and social development as well as human safety. *The 2023 Report of Lancet Countdown on health and climate change* (Romanello et al., 2023) states that the number of deaths among people aged 65 and

older related to heatwaves has increased by 85% compared to the average from 1986 to 2005.

Trade protectionism has intensified, and the traditional trade governance system has been shaken. Some countries' solution of having 'small yards with high walls' and even 'decoupling and disconnection' has torn apart the global economic network. However, an order that can resolve trade conflicts based on national security has not yet been established, and the fragmentation of the global trade and investment network has become more outstanding. According to Global Trade Alert, from the start of the year to 11 May 2024, there were 921 incremental trade restrictions measures globally (World Trade Organization, 2024).

Geopolitical instability brings more uncertainty. The Russia–Ukraine conflict and the Israel–Palestine conflict have continued, and attacks on merchant ships in the Red Sea have disrupted major shipping routes. It is becoming more difficult to secure food, energy and resources supplies. Fluctuations of non-economic factors have caused increasing disturbances on global trade and economic environment.

4.2 Internal challenges

China has transitioned from high-speed growth to high-quality development, and strong efforts are still required to continuously promote sustainable growth. In innovation development, China's capabilities to achieve major original innovations need to be improved, with significant difficulty in achieving breakthroughs in key core technologies. The support of finance for technological innovation also needs to be strengthened. In coordinated development, the task of narrowing regional development gaps is difficult, and there is still significant room for improvement in rural development. The construction of a unified national market needs to be further strengthened. In green development, there are still many challenges in areas such as territorial spatial

governance, resource conservation and intensive utilisation, ecological protection and restoration and ecosystem carbon sinks. In shared development, China's income distribution is still not reasonable enough, and residents still face difficulties in employment, education, healthcare, childcare, elderly care and housing.

5 Actions China is taking to achieve sustainable growth

Development is the eternal theme of human society. Currently, China is advancing on the Chinese path to modernisation with high-quality development in an all-round way to realise sustainable growth. China's development will also bring more opportunities for win-win cooperation between China and foreign countries, injecting more vitality and certainty into global economic growth.

China is developing new quality productive forces by adapting to local conditions, so as to continuously improve economic operation efficiency. President Xi Jinping proposed the concept of 'new quality productive forces' in 2023 for the first time and elaborated these many times afterwards, emphasising that developing new quality productive forces is an intrinsic requirement and important focus for promoting high-quality development, and it is necessary to accelerate the development of new quality productive forces. In terms of new industries, new models and new momentum, China is focusing on strengthening technological innovation, especially original and disruptive technological innovation, fostering new momentum for the development of new quality productive forces. In terms of the transformation and upgrading of traditional industries, China is accelerating efforts to promote technical transformation and the upgrading of manufacturing industry, to cultivate and strengthen

advanced manufacturing clusters, and to establish national new industrialisation demonstration areas. In terms of new production relations, China is establishing a high-standard market system, innovating the allocation of production factors, so as to ensure that all advanced and high-quality production factors flow smoothly into the development of new quality productive forces. In terms of grooming talents, China is improving its intellectual property protection (IP) system, attaching importance to talent cultivation and incentives, so as to leverage China's advantage of having the global largest pool of scientific and technological talents.

China is forming a high-quality socialist market economic system, so as to fully leverage the advantages of a unified large market. Throughout history, China has always regarded respecting the market and serving enterprises as the cornerstone of its economic planning and the focal point of implementing economic policies. The Chinese government has consistently promoted sufficient flow of factors, further improving the ease of doing business and fully utilising advantages of the super-large market. In terms of implementing the 'the two-irresolution' principles (i.e. no irresolution about consolidating and developing the public-owned economy, and no irresolution about encouraging, supporting and guiding the non-public owned economy), China is breaking through institutional and system barriers that hinder the expansion of private investment, further addressing prominent issues in market access, factor acquisition, fair law enforcement and rights protection, and accelerating progress on the *Private Economy Promotion Law*. In terms of building the unified large market, China is strengthening the inelastic constraints of fair competition review and stepping up efforts on antitrust and anti-unfair competition. China is further standardising government procurement and tendering practices, establishing standardised rules for local competition on investment attraction, and focusing on breaking through various forms of implicit barriers, local protection and market segmentation. In terms of improving fundamental market mechanisms, China is strengthening

IP protection, refining market access mechanism, and enhancing social credit and supervision mechanisms.

China is actively promoting green transformation, so as to develop the green economy. Green transformation is a paradigm shift involving changes in concepts and methods of production and lifestyle. China is continuously strengthening its ecological civilisation construction and promoting green and low-carbon development. In terms of comprehensive ecological environment management, China is in the process of thoroughly implementing air, water and soil pollution prevention and control measures, as well as quality control improvement actions, advancing establishment of national parks, implementing major biodiversity protection projects, and improving the ecological protection compensation system. In terms of cultivating green growth momentum, China is promoting green transformation of industrial structure, energy structure, transportation structure and urban–rural construction development, implementing a comprehensive conservation strategy, and accelerating the formation of green and low-carbon supply chains. In terms of carbon peaking and carbon neutrality, China is establishing a carbon emissions statistical accounting system, a product carbon labelling certification system and a product carbon footprint management system and improving the carbon market trading system and the voluntary greenhouse gas emission reduction trading system.

China is optimising income distribution, so as to enhance social equity. China has entered a historical stage of substantially promoting common prosperity. It is necessary to let the fruits of modernisation benefit all people more fairly. In terms of primary distribution, China is increasing the proportion of labour compensation, improving the minimum-wage system, resolutely correcting employment discrimination based on gender, age or education, and ensuring the payment of migrant workers' wages to be duly made. In terms of redistribution, China is narrowing the basic pension insurance coverage gap between regions and

between employees and non-employees, increasing transfer payment to low-income groups such as recipients of Allowance for Minimum Living Guarantee, optimising the role of taxation in income adjustment, and accelerating the establishment of a housing system that combines renting and purchasing. In terms of public services and social safety nets, China respects objective regularities of population movement and is facilitating public services to follow movements of people. China is actively addressing aging population related issues, improving childbirth support policies, and improving the stratified and categorised social assistance system. China is also coordinating policies for poverty prevention and low-income population assistance.

China is continuing with high-standard opening-up. China's development cannot be separated from the world, and the world's prosperity also needs China. China is proactively aligning with high-standard international rules for economic and trade, insisting on pursuing win-win cooperation with countries around the world. In terms of market access, China will continue to shorten the negative list for foreign investment, to fully cancel foreign investment access restrictions in manufacturing sector, and to relax market access in the service sectors such as telecommunications and healthcare. In terms of open competition, China will implement national treatment for foreign enterprises, ensuring equal participation in government procurement, bidding and standard-formulation in accordance with the law, and will address issues related to cross-border data flow. In terms of optimising services, China will strengthen the guarantee and support for foreign investment, and enhance the convenience of foreign personnel in working, studying and traveling in China.

China is deepening cooperation with countries and regions in Eurasia. In the current international landscape with increasing turmoil, growth in Eurasia is of strategic significance and global impact, affecting world peace, stability and prosperity. China will continue to deepen cooperation with countries and regions

in Eurasia, to support Chinese enterprises to invest in various countries, actively expanding cooperation in emerging areas such as technological innovation, advanced manufacturing, green energy, digital economy and artificial intelligence in the local market they operate overseas. China is also practically implementing the medium-term action plan for jointly building BRI and striving to create more landmark projects. China is improving the level of visa facilitation and expanding direct flight connections, practicing true multilateralism, advocating for a world of equal and orderly multipolarity and inclusive economic globalisation that benefits all, and continuously promoting the development of a community with a shared future for humankind.

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What can European and Asian Economies Learn from the Work of the Network for Greening the Financial System and its Climate Scenarios?

Antoine Bakewell – Paul Champey

The Network for Greening the Financial System (NGFS) has fostered global collaboration, which plays an instrumental role in the development of central banks' and supervisors' climate action. This article investigates how European and Asian economies can draw valuable lessons from this work, especially the NGFS Scenarios.

The NGFS has developed climate macro-financial scenarios to help both supervisors and financial actors better identify, assess and address climate and environmental risks. These scenarios emphasise the value of a proactive approach to understanding the long-term implications of these risks. Utilising the NGFS Scenarios, financial institutions and supervisors can effectively evaluate the transition and physical risks associated with climate change.

The findings suggest that the transition to a net-zero economy is both feasible and advantageous for European and Asian countries, offering substantial economic benefits and mitigating climate impacts. However, accelerated action is required. Central banks, financial supervisors, and both the public and private sectors should collaborate to integrate climate and environmental risks and contribute to a sustainable economic

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transition. This article highlights the importance of strategic planning and international cooperation in promoting climate resilience and sustainable growth in Europe and Asia, as well as other regions of the global economy.

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1 Introduction

In 2018, severe droughts led to critically low water levels in the Rhine River, one of the key shipping routes in Germany and Europe, reducing German industrial production by up to 1.5% (Ademmer et al., 2020). As the risk of repeated droughts is rising (the situation occurred again in 2022), studies have found that the increased transportation costs caused by low water levels could have a negative impact on Germany's economy (Schattenberg, 2023), which could in turn affect its economic partners. This is only one dimension of the many recent examples of how our interconnected modern economies strongly depend on the services provided by ecosystems, highlighting the significant impacts that climate change and nature degradation can have on the economy.

Following its first report (Network for Greening the Financial System, 2018) and its later statement on nature loss (Network for Greening the Financial System, 2022), the Network for Greening the Financial System (NGFS) acknowledges that climate-related and, more generally, nature-related developments are macro economically material developments and, as such, a source of financial risk. As such, central banks and supervisors should consider these developments in the pursuit of their mandates. The misalignment between the time horizon of climate change and that of economic and financial players, which Bank of England

Governor Mark Carney called the 'tragedy of the horizon,' (Carney, 2015) leads financial actors to underestimate climate-related risks. To correctly reflect climate-related risks in the valuation of assets, it is therefore necessary for economic and financial actors to extend the time horizon used to assess risks. In this sense, the 'greening of the financial system' to which the NGFS is contributing means making financial actors aware of the way in which modern economies are rooted in nature. When climate and environmental (C&E) risks are correctly priced, the business case for sustainable models and nature-friendly economic policies becomes abundantly clear.

To help financial institutions and their supervisors correctly assess C&E risks, evaluate risk exposure and measure potential impacts, the NGFS has developed climate scenarios. These scenarios are a recent addition to the financial sector's toolkit and aim to assess the various risks that can affect financial stability and price stability, and to integrate the many specificities of climate-related developments. They also serve as a basis for climate scenario analysis and climate stress-testing, which leverage a 'classic' tool that measures the resilience of financial institutions and of the broader financial systems to climate-related shocks.

The global context is marked by the accentuation of a 'polycrisis' (Tooze, 2022), in which the impact of nature-loss becomes more pressing, but which also affects both the speed at which the ecological transition is carried out and the very capacity of public and private players to carry out this transition. Climate action may no longer be at the top of the international agenda due to competing (geo-) political, economic and social priorities, as well as a politically-motivated backlash towards considering ESG (environmental, social, and governance) in financial decision-making and developing a more sustainable finance. However, climate scenario analysis shows that all countries have an interest in carrying out the transition towards a net-zero, climate-resilient economy, in a swift and coordinated manner.

In this article, we dive into what European and Asian economies can learn from the NGFS Climate Scenarios and how the work of the NGFS can inform sustainable economic policy strategies and initiatives in these regions. After outlining the rationale for central banks and financial supervisors to look at C&E risks and the way in which the NGFS helps them do so (Section 2), we present the NGFS Climate Scenarios (Section 3) and share the key findings they provide in relation to European and Asian economies (Section 4). Finally, we look at how initiatives within the financial system and beyond can inform sustainable action in Europe and Asia (Section 5).

Box 1
About the NGFS

The Network for Greening the Financial System (NGFS), launched at the Paris One Planet Summit on 12 December 2017, is a group of central banks and supervisors that are willing to share best practices on a voluntary basis and to contribute to the development of environment and climate risk management in the financial sector, and to mobilise mainstream finance to support the transition toward a sustainable economy.

The NGFS brings together 138 central banks and supervisors and 21 observers. Together, they span five continents, operate in economies that account for more than 88% of global greenhouse gas emissions and are collectively responsible for the supervision of all global systemically important banks and 80% of the internationally active insurance groups.

2 The implications of climate change and nature degradation, and how the NGFS helps its members approach C&E risks

2.1 Climate change and nature degradation are a source of risk for the economy and the financial system

Events induced by climate change have visible macroeconomic impacts, highlighting the materiality of physical risks even in the short term. Globally, 2023 was the hottest year on record, with the average global temperature 1.5 °C above pre-industrial levels between February 2023 and January 2024. In Europe, extreme heat events are becoming more frequent, and the intensity of rainfall and the severity of droughts are increasing (European Environment Agency, 2024). As the first *European Climate Risk Assessment* emphasises, if decisive action is not taken now, hundreds of thousands of people may die from heatwaves by the end of the century, and economic losses from coastal floods alone may exceed EUR 1,000 billion per year. These developments also have far-reaching consequences for food and energy security and ultimately for the global economy: with USD 38,000 billion worth of damage each year between now and 2050, the global economy will probably be about 20% smaller by 2050 than it would have been if we had acted earlier (Kotz et al., 2024).

In addition to climate change, risks stemming from nature degradation and biodiversity loss are also becoming increasingly material from an economic and financial perspective. Far from being disconnected from the physical world, finance and the economy are deeply rooted in nature, with over half the world's total GDP being moderately or highly dependent on nature and its services and, as a result, exposed to risks from nature loss. Highlighted by the Dasgupta report on the economics of biodiversity (Dasgupta, 2021), this dependence has been confirmed by studies by De Nederlandsche Bank (2020), Banque

de France (Svartzman et al., 2021), the European Central Bank (Boldrini et al., 2023) or the World Bank Group and Bank Negara Malaysia (2022), among others. These found that 75% of loans to businesses in the Eurozone are heavily dependent on at least one ecosystem service, as are 42% of the value of shares and bonds held by French financial institutions, and 54% of analysed Malaysian commercial loans portfolios. The deterioration of ecosystem services can therefore have widespread consequences on the economy and financial system.

The transition to a carbon-neutral and nature-positive economy must be led in a swift and orderly manner to minimise the impacts of physical risks. The transition to a sustainable economy is necessary to prevent further risks from materialising, e.g. due to reaching tipping points in the climate system (Lenton et al., 2019). To keep warming well below 2 °C and reach the goal set by the Paris Agreement, countries must reduce emissions by at least 45% compared to 2010 levels by 2030 and the global economy should reach net zero before 2050. While the targets set by countries in their Nationally Determined Contributions (NDCs) and net-zero pledges could limit global warming to 2.1 °C, they may still not be enough to avoid reaching catastrophic tipping points. The ambition, while almost adequate, must still be increased as NDCs reveal an increase of almost 9% in global greenhouse gas emissions in 2030 compared to 2010. Implementation will be critical as the gap between targets and current policies remains – the latter currently lead to a warming of 2.7 °C in 2100, but temperatures will continue to rise after that date.[5] To meet the objectives of the Kunming–Montreal Global Biodiversity Framework, drivers of biodiversity loss will have to be reduced. All actors, including financial institutions, will have to take part in the effort to halt

[5] See *The Climate Action Tracker Thermometer* (https://climateactiontracker.org/global/cat-thermometer/) and the *Emissions Gap Report 2023* by the United Nations Environment Programme (https://wedocs.unep.org/bitstream/handle/20.500.11822/43922/EGR2023.pdf?sequence=3&isAllowed=y).

and reverse biodiversity loss: according to Banque de France estimates, the annual terrestrial biodiversity footprint of French financial institutions is comparable to the loss of at least 4,800 km² of 'virgin' nature, which corresponds to the total artificialisation of an area equivalent to almost twice the Paris urban area each year (Svartzman et al., 2021).

Furthermore, the more we wait, the higher the cost to implement the transition to resilient economies will be. Recent studies by Banque de France have found that the earlier and more gradually the transition is implemented, the lower the risks to macroeconomic stability (Allen et al., 2023). By contrast, if not properly anticipated, the transition to carbon neutrality could also lead to a rapid succession of shocks, increasing macroeconomic volatility. In turn, this increased volatility could disrupt the decisions of economic agents, weaken inflation expectations and eventually constitute a real challenge for the conduct of a monetary policy adapted to the challenges of transition. Considering the far reaching macroeconomic implications of these developments, there is a strong rationale for central banks and financial supervisors to further look into these risks and better understand how they can affect the financial system. The launch of the NGFS in 2017 sought to respond to its Members' need to increase knowledge and capacity on these topics.

2.2 The NGFS facilitates the integration of C&E risks into the activities of central banks and supervisors

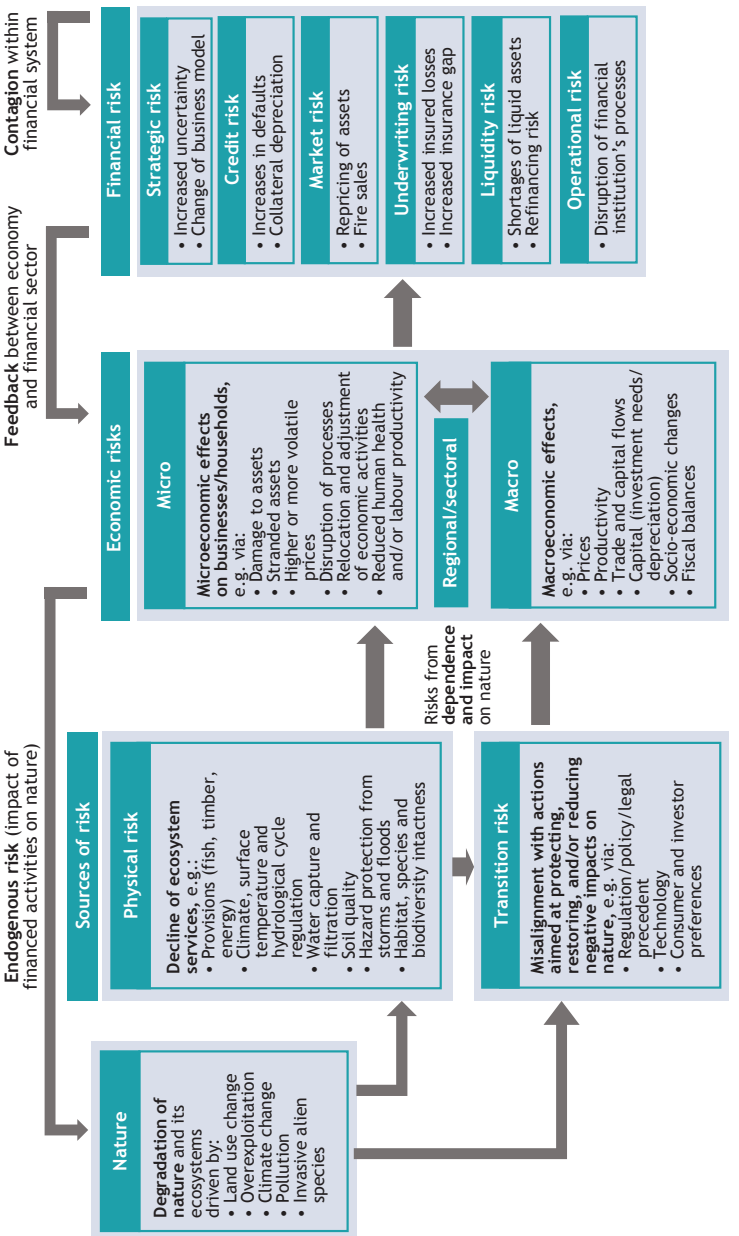
Based on experience-sharing between its Members and with its partners, the NGFS is working on several priority areas for central banks and financial supervisors. These include strengthening supervision of financial institutions' climate-related risks, continuing to develop and enhance climate scenarios for the financial system, further understanding the impacts of climate change on monetary policy and providing further guidance to central banks' and supervisors' own transitions to net zero.

Furthermore, the NGFS also facilitates knowledge sharing on climate- and nature-related litigation and legislation, emerging research topics and issues regarding climate-related data, by bringing together experts throughout the membership.

The NGFS has also led work to step up its efforts to increase knowledge and skills within its membership. It has helped central banks and supervisors to design and develop in-house training and capacity-building strategies in the area of climate-related and environmental risks and to mainstream the consideration of nature-related risks across the NGFS' areas of work, as well as to raise awareness about *blended finance* and to explore potential regulatory and practical barriers to scaling-up blended finance in emerging market and developing economies (EMDEs).

The NGFS has helped its members to improve their understanding of C&E risks and how they should be integrated within the pursuit of their monetary and financial stability mandates. In order to understand C&E risks in a harmonised way, the NGFS has contributed to the development and promotion of a common language for financial players. This language is based on the distinction between physical and transition risks: while the former result from damage caused directly by weather and climate phenomena or by the degradation of nature and the loss of ecosystem services, the latter can materialise when a low-carbon, nature-protecting economic model is put in place, particularly when this is done in a disorganised manner. The NGFS conceptual framework on nature-related financial risks operationalises this common approach to C&E risks for central banks and supervisors, providing them with a method for identifying and assessing such risks (NGFS, 2023a).

Figure 1. Transmission channels from nature degradation to financial risks



Source: Network for Greening the Financial System (2023a)

By looking at the implications of C&E developments for macroeconomic and financial stability, the NGFS is helping its members integrate these considerations into their activities. The NGFS sees its reports and tools as public goods that can be leveraged by its memberships as well as by the broader financial community. The climate scenarios embody the way the work of the NGFS contributes to raising awareness and initiating action throughout the financial system.

3 The NGFS has developed climate scenarios to help financial actors better assess and address climate-related risks

3.1 The specificities of C&E risks require a forward-looking approach to effectively assess their implications

Although climate change is increasingly acknowledged as a potential systemic risk to the economy and the financial system, it poses considerable challenges from a methodological perspective. While risk-based assessment is traditionally based on historical trends and extrapolation from observed data, the effects of climate change have barely started to materialise. This means that the usual backward-looking approach can only lead to underestimating the potential impacts stemming from climate change, as the climate disasters already experienced are but a glimpse of what a world with a +2 °C increase could look like. Furthermore, transition risks emanating from insufficiently anticipated climate action and inconsistencies in expectations around climate-related trends are also subject to strong uncertainty, as climate and transition policies can take several forms (carbon pricing, investment, environmental standards, etc.) and are highly dependent on the global geopolitical context, while shifts in behaviors can lead to switches in market dynamics.

In short, climate change exposes the financial sector to a radical (or Knightian) uncertainty, where a complete mapping and quantification of the possible developments is impossible. Without the appropriate analytical toolkit, the economy is left vulnerable to 'green swan' events (Bolton et al., 2020), potentially occurring from the distribution tail of climate-related shocks.

Furthermore, climate-related risks encompass a wide variety of components falling outside the financial sphere, making a transdisciplinary approach imperative. Geopolitical, social, cultural, technological (and other) factors need to be taken into account when assessing the financial implication of climate change, otherwise the analysis is likely to miss key transmission channels and particular developments, failing to capture adequately the risks at stake.

To overcome this 'epistemological obstacle' (Bachelard, 1938), scenario-based analysis offers interesting solutions to assess the resilience of the financial sector to climate-related risks. A scenario is a hypothetical internally consistent future derived under a coherent set of hypotheses, aiming to explore uncertain phenomenon in a forward-looking fashion. From a financial risk perspective, conducting a scenario-based analysis allows the exploration of different plausible futures, and the identification of vulnerabilities that might arise in such a context. By (stress-) testing the ability of corporates in their portfolios to overcome the economic turmoil arising from climate-related risk in various scenarios, financial institutions can start to overcome the 'tragedy of the horizons.' As Mark Carney highlighted in his speech, climate change's main challenge is that, even though some impact may start to emerge, most of its effect will materialise beyond the usual business, political or financial cycles, falling outside of the time horizon of supervisors' traditional analytical framework. Over the past years, climate scenarios have multiplied to offer insights into the various implications of climate change, with

a focus on the mitigation actions required to prevent the global mean temperature increase from exceeding 2 °C. These scenarios typically project pathways until 2050 and help their users bridge the horizon gap in their assessment.

Although they cannot completely overcome all of the challenges posed by climate change (e.g. most of the models used for scenarios implicitly focus on optimal economic pathways, failing to include considerations such as geopolitical tensions or constraints arising from the need to ensure the social acceptability of climate and transition policies), climate scenarios offer valuable insight into potential vulnerabilities and they benefit from continuous improvements through the enrichment of the models used in the global research and financial community. In particular, climate scenarios can help the financial system to understand the structural changes required for the economy (especially within the energy sector) to achieve a transition and to reallocate their portfolio accordingly.

3.2 The NGFS Scenarios: A tool to assess climate risks

While traditional climate scenarios[6] offer useful insight to help financial companies assess the impact of climate change, they often lack granular and macroeconomic data to be effectively incorporated into the financial institutions' toolbox. Most of these climate scenarios are developed for policymakers and climate scientists rather than financial actors, and therefore usually only focus on the GDP impact from transition or physical risk and fail to provide the impact on other highly relevant variables for the financial system, such as inflation, unemployment, interest rates, etc. Furthermore, global climate scenarios usually display results at the global or regional level, while financial

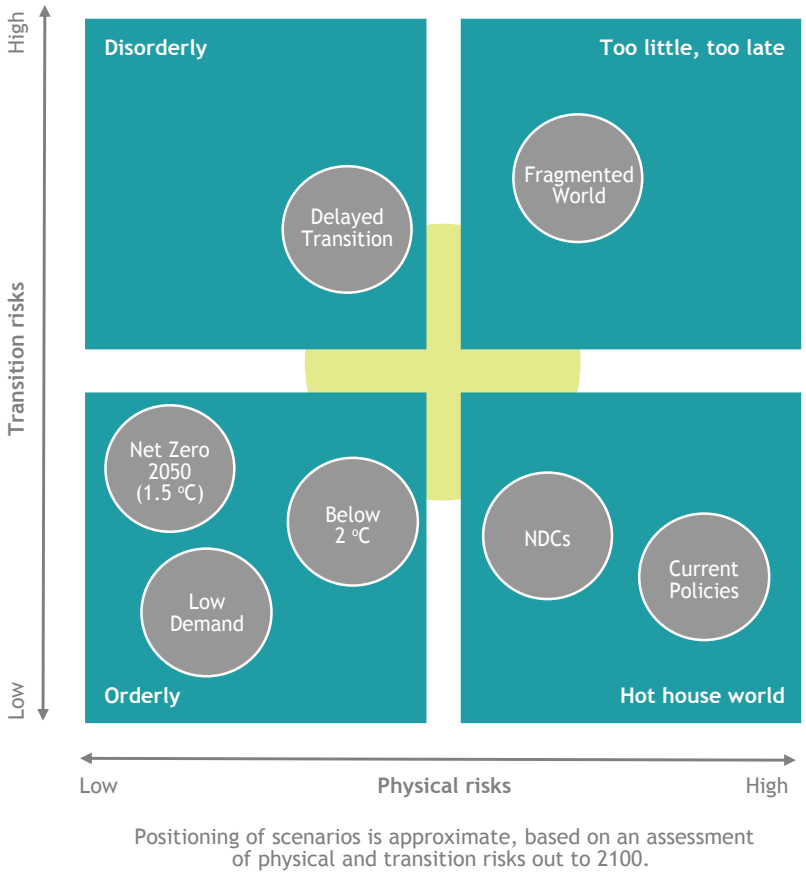
[6] Such as those developed by the International Energy Agency or the Intergovernmental Panel on Climate Change.

institutions' traditional scope of analysis is mostly national. In order to address these gaps and help its members (and the broader financial system) improve their understanding and the forward-looking assessment of climate-related risks, the NGFS has developed, together with leading climate and economics research institutions, a set of global macro-financial climate scenarios. The NGFS Scenarios' purpose is to provide a common starting point for analysing climate-related risks and assessing their potential impact on the financial sector. Conceived as a public good, they are under continuous improvement and available on the NGFS Scenarios Portal.[7] The NGFS Scenarios provide useful information for numerous countries and a wide range of applications. As a reminder, they should not be seen as a forecast, but as plausible futures allowing users to perform a climate risk-assessment and explore the possible impacts stemming from each one of them.

To explore the potential impacts of climate change, the NGFS has developed seven possible futures (narratives), where global climate ambition and key socio-economic assumptions (policy timing, coordination, technologies, etc.) differ, leading to different end-of-century temperature outcomes. All these narratives can be compared within a common reference framework, which groups the NGFS Scenarios according to their respective level of transition and physical risk (see Figure 2). Further information on the different NGFS Scenarios' narratives and assumptions is available in NGFS (2023b).

[7] For more information on the NGFS Scenarios, please visit https://www.ngfs.net/ngfs-scenarios-portal/

Figure 2. The NGFS Scenario framework in its latest vintage (Phase IV)



Source: NGFS (2023b)

As mentioned above, several other international organisations, such as the Intergovernmental Panel on Climate Change (IPCC) or the International Energy Agency (IEA), also provide global climate scenarios, and the NGFS Scenarios share similarities with their modelling framework – allowing for comparison of the results while providing unique insights on macro-financial developments resulting from both transition and physical risks. Similarly to the IPCC Scenarios, the NGFS Scenarios rely on integrated assessment models (IAMs) to simulate the required changes in the energy

system and emission reductions to meet countries' climate targets. Furthermore, the NGFS Scenarios build on the IPCC AR6's scenario framework developed to allow a sound comparison across the numerous IAMs' results.

Finally, when looking at the results of the NGFS Scenarios, one should be aware of their limitations. Although they provide very useful insights on climate change implications, the NGFS Scenarios are not a standalone product and are meant to be complemented by further analysis from users. The NGFS has consistently acknowledged the limitations of its scenarios and recently offered guidance in addressing those shortcomings in one of its publications (NGFS, 2024a).

Box 2
Modelling framework of the NGFS Scenarios

The NGFS Scenarios follow a suite-of-models approach, bringing together several complementary models and leveraging each model's strengths to obtain a complete and granular yet consistent dataset.

Transition risks is captured by integrated assessment models (IAMs) – models that simulate the economic and energy system, but which also include a climate and land-use module. While some of these models can be used to infer optimal mitigation policies, the IAMs used by the NGFS are geared toward a positive description of the climate-energy-economy nexus rather than a normative approach – which calculate the required shadow carbon price (a proxy for all climate policies) to meet a predefined temperature target at the end of the century in a cost-effective fashion. The NGFS Scenarios use three different first-class IAMs[8] to account for model uncertainty. Those IAMs provide results at the regional level,

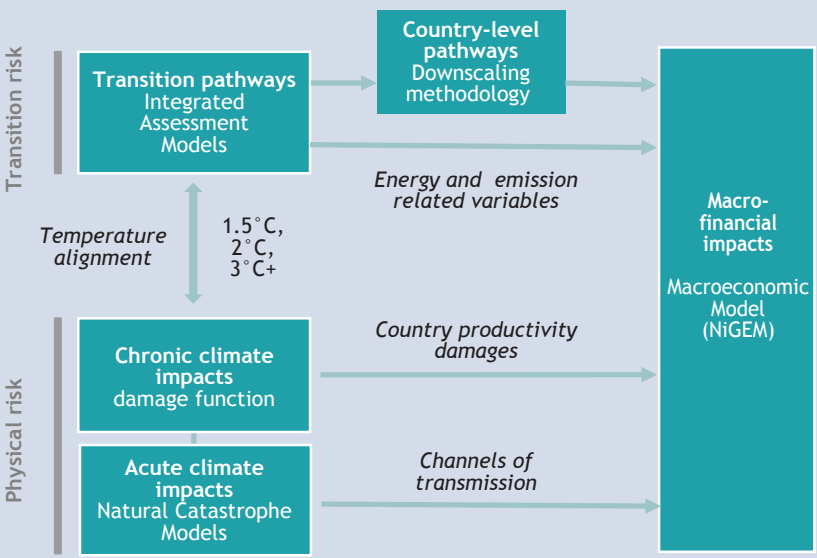
[8] GCAM, Remind-MAgPIE and MESSAGEix-GLOBIOM.

which are then downscaled to the country level. To capture the aggregated impact of chronic physical risk, the NGFS Scenarios use a damage function estimating GDP loss due to climate change.

The IAMs explore structural changes in the energy sector and the main emissions reduction levers. Chosen outputs of the IAMs, such as energy variables, convey shocks into the macroeconomic model NiGEM, which computes the impact on various macroeconomic and macro-financial variables (GDP, inflation, interest rates, etc.) of both physical and transition risk.

Finally, the macroeconomic impact stemming from four acute physical hazards (heatwaves, droughts, tropical cyclones and riverine floods) are modelled using natural catastrophe models. Figure 3 gives an overview of the suite of models used by the NGFS. Further details on the models used and their coupling are available in NGFS (2023c).

Figure 3. Overview of the NGFS Scenarios' modelling framework



Source: NGFS (2023c)

4 The NGFS Climate Scenarios show that transition to a net-zero economy is within reach and beneficial to European and Asian countries

4.1 A net-zero pathway for the energy mix of Europe and Asia, although ambitious, is still within reach

In the following, the analysis focuses on a few results of some of the NGFS Scenarios applied to countries in Europe and Asia, using the outputs of the integrated assessment model Remind-MAgPIE. As each IAM models a different combination of country consolidation, we have selected the following Remind regions: EU 28,[9] Non EU-28 Europe, Reforming economies[10]and Asia.[11]

To allow a clear-cut analysis, this section only explores the results of two NGFS Scenarios, which are strongly contrasted regarding climate ambition: *Net Zero 2050* and *Current Policies*. Net Zero 2050 is a scenario close to the IPCC's RCP 1.9 pathway[12] which limits global warming to 1.5 °C compared to the pre-industrial level. In this scenario, stringent climate policies are immediately implemented in an orderly and cooperative manner to reach net-zero CO_2 emissions in 2050 at the global level. For countries which have publicly committed to even more ambitious targets (e.g. net zero in 2050 for all greenhouse gases (GHG)), the latter is

[9] This region includes the United Kingdom.

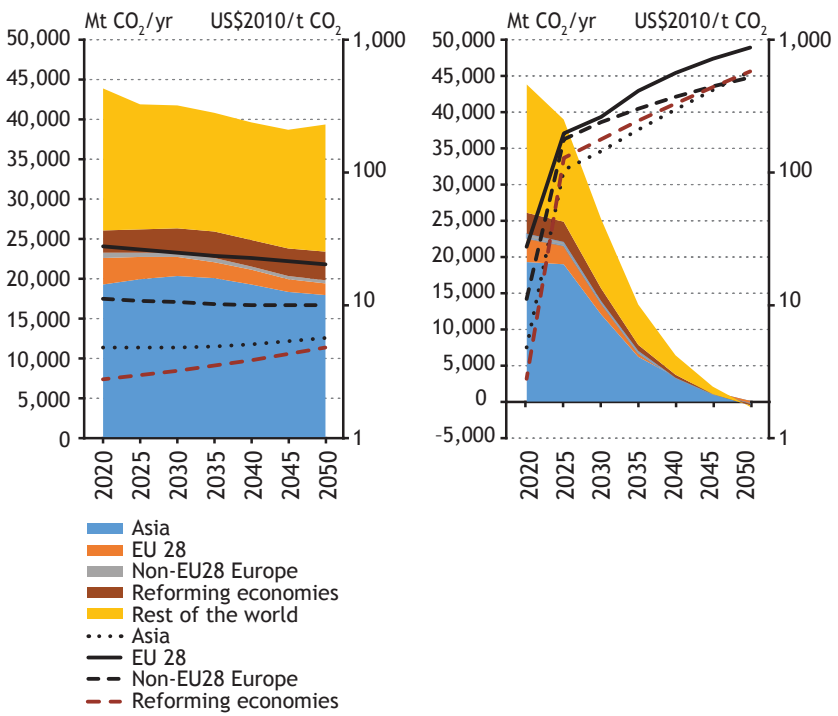
[10] The individual countries (ISO codes) for this region are: ARM, AZE, BLR, GEO, KAZ, KGZ, MDA, RUS, TJK, TKM, UKR, UZB.

[11] This region includes all the remaining Central and Eastern Asian countries, with the exception of Japan which is modelled separately in Remind.

[12] See the IPCC's *Sixth Assessment Report* (https://www.ipcc.ch/assessment-report/ar6/). RCP stand for Representative Concentration Pathways, it represents the radiative forcing (in W/m^2) reached by the scenario at the end of the century, which then determines the global temperature.

instead considered. Current Policies, on the other hand, assumes that only currently implemented policies are preserved, which in the Remind model leads to a global mean temperature increase of 2.8 °C by the end of the century, thus failing to meet the Paris Agreement's temperature target.

Figure 4. Comparison of carbon price and CO_2 emissions pathways between Current Policies (left) and Net Zero 2050 (right)



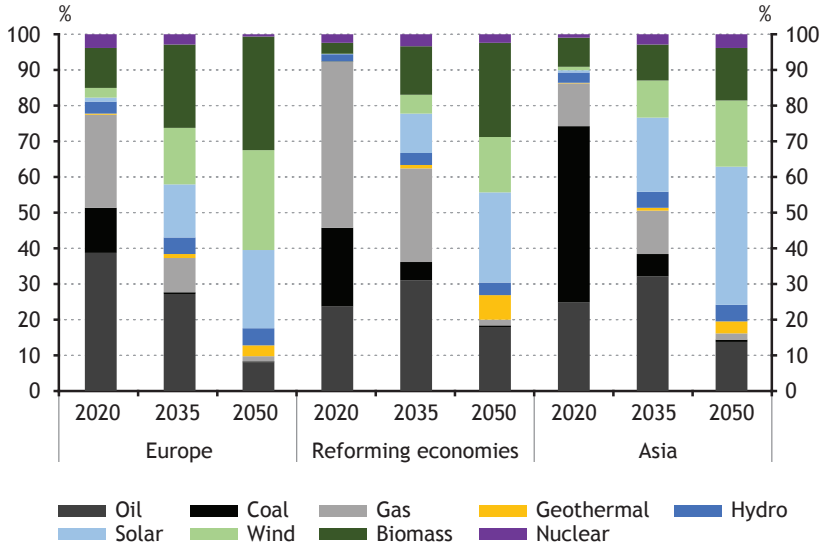
Source: Authors, based on data from NGFS Scenarios Phase IV, NiGEM model (with Remind-MAgPIE inputs)

The above IAM results show that more stringent climate policies (as proxied by the shadow carbon price) are driving the reduction in GHG emissions. By changing the relative cost of the different energy sources in favour of clean ones and by making carbon storage and capture technologies economically viable, it ensures that the optimising agents in the models respect the carbon budget

required to meet the temperature target. The carbon price varies considerably between the two scenarios, reaching 875 USD/t CO_2 in 2050 for the European Union in Net Zero 2050, and only USD 20 in Current Policies. This difference is well reflected in the CO_2 emissions: whereas they only slightly decrease at the global level until 2050 in Current Policies, they decrease steeply from 2025 in all regions, reaching a negative level in the EU from 2040, and globally from 2050.

With the majority of CO_2 emissions induced by energy consumption, the IAMs also show that any transition scenario will therefore require significant changes in the energy sector. The IAMs' main strength is their detailed representation of the energy sector, which helps better understand how an economy can feasibly reach a carbon-neutral state. Figure 5 (below) displays a feasible and economically optimised primary energy mix calculated by Remind for the Reforming economies, Asia and Europe, which would allow net-zero CO_2 emissions in 2050 to be achieved. One striking aspect is the change in the relative importance of high-emissions energy sources, such as coal and oil in Asia, which decrease from 50% and 25% of the energy mix in 2020 to less than 1% and 14%, respectively, in 2050. These fossil fuels are mostly replaced by renewables energies, mainly solar and wind power, which reach 39% and 15% of the energy mix in 2050, respectively. The NGFS Scenarios show that a net-zero pathway for the energy mix of both Asia and Europe, although ambitious, is still within reach.

Figure 5. Primary energy mix for Reforming economies, Asia and Europe in the Net Zero 2050 scenario



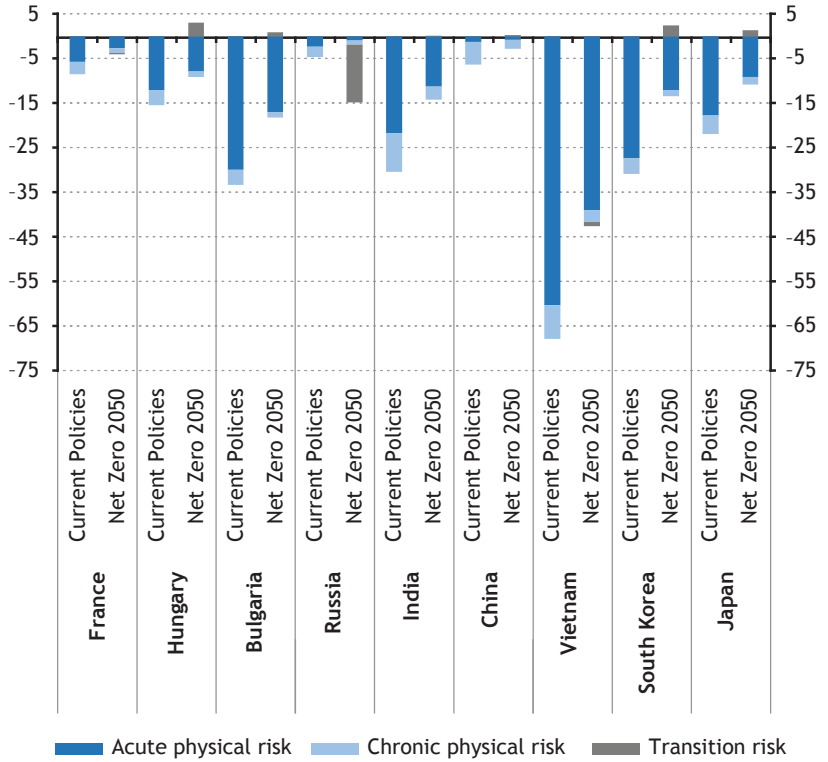
Source: Authors, based on data from NGFS Scenarios Phase IV, Remind-MAgPIE model

4.2 A timely and ambitious transition is unambiguously preferable to experiencing unmitigated climate change

In addition to exploring different pathways for Europe and Asia regarding climate policy and energy mix, NGFS Scenarios also provide an estimate the potential macroeconomic impacts induced by the suite-of-models' narratives. In this sense, NiGEM is a key component of the NGFS Scenarios, since it leverages the results of IAMs on the real economy to compute the impact on countries' various macroeconomic and macro-financial variables (GDP, inflation, interest rates, etc.) of both physical and transition risk. All NiGEM results are expressed in percentage deviation point with regard to a baseline, representing a fictional scenario without any climate-related risks. The results below provide an overview of the potential macroeconomic impacts of the change in

the energy mix for a sample of individual countries across Europe and Asia.

Figure 6. Macroeconomic impact of climate-related risks in 2050 (in % of GDP) for Current Policies and Net Zero 2050 scenarios for a selection of countries



Source: Authors, based on data from NGFS Scenarios Phase IV, NiGEM model (with Remind-MAgPIE inputs)

Not surprisingly, the Current Policies scenario, by failing to limit temperature increase, brings much higher physical risk impact than Net Zero 2050. The results of the simulation also show that, compared to the sampled European countries, the Asian countries in the sample tend to be much more exposed to both chronic and

acute physical risk. Some countries seem less subject to transition risk, which can even have a positive foreseen impact on GDP in 2050.This growth effect can largely be explained by the fact that among the various transition channels from the IAMs to NiGEM is the recycling by governments of the revenues from the implemented carbon price. In Net Zero 2050, it leads to a sustained increased in public investment, which then strengthens demand and the overall economy. One striking exception is Russia, which may experience significant losses due to transition risk and the phasing-out of fossil fuels in the Net Zero 2050 scenario, while suffering limited impacts from physical risk. It appears, however, to be the only country not to benefit from the Net Zero scenario compared to the Current Policies scenario. Nonetheless, these results show that there are strong benefits for a large majority of countries to take the path of a timely and ambitious transition, rather than suffer from the loss induced by climate change. Even though the macroeconomic simulation stops in 2050, this observation is expected to become even more obvious afterwards: net-zero economies should be gradually less affected by transition shocks, while physical risks impact will continue to increase under the Current Policies scenario and stabilise in the Net Zero 2050.

This section showed a glimpse of the diversity of data provided by the NGFS Scenarios and their potential use for risk assessment. However, like any modeling tool, it is highly dependent on the hypothesis and framework on-boarded in each component of its suite-of-models. Although IAMs are very effective tools to explore structural changes in the energy sector and the main emissions reduction levers, they compute their results over five-year steps, which limits their ability to capture potential short-term frictions and shocks that might occur within this timeframe. Physical risk is also computed in a backward-looking statistical fashion, failing to explore contagion and spillover effects across different countries from catastrophic climate events. To address these shortcomings, the NGFS is currently calibrating its first

set of short-term scenarios, which will focus on exploring such possible events. This new product will allow users to conduct risk assessment under a more standard timeframe with regards to the financial sector (three to five years). The narratives developed for those scenarios are already available in NGFS (2023d).

5 European and Asian economies must accelerate their action to reach the climate and nature goals

5.1 Central banks and financial supervisors across Europe and Asia can contribute to the transition by climate proofing the pursuit of their core mandates

The NGFS Scenarios show that economies in Europe and Asia must pursue their efforts to reach Net Zero by 2050: central banks and financial supervisors can support this effort by fostering a financial system that can accompany and accelerate the transition. By its work and best-practices sharing, the NGFS encourages both financial institutions and its members to better integrate C&E considerations in their core activities. For instance, the ECB as a supervisor of financial institutions, has set as a priority the effective remediation of shortcomings in governance and the management of climate-related and environmental risks, asking banks to adapt their business strategies and risk management frameworks by the end of 2024 (European Central Bank, 2023). The Basel Committee on Banking Supervision recently updated its *Core Principles for Effective Banking Supervision* (BIS, 2024) to clarify how to approach and account for climate-related financial risks: supervisors should consider the implications of climate change and the transition to net zero in their risk assessment of banks,

and can require banks to submit information that allows for the assessment of the materiality of these risks drivers.[13]

The use of climate scenario analysis and climate stress-testing is becoming widespread among central banks and financial supervisors. While only four stress-testing exercises had been completed within the NGFS membership in 2021, this number has now risen to more than 60.[14] At the request of the European Commission, a climate change stress-test exercise is being conducted across the European banking and insurance sectors and the European fund industry to assess the ability of the European financial system to accompany the decarbonisation of the European economy by 2030.[15] As climate scenario analysis and stress-testing become more mainstream, the NGFS is now working to develop scenarios for assessing broader nature-related economic and financial risks (Network for Greening the Financial System, 2023e).

NGFS members are also integrating sustainability issues more directly into the management of their own portfolios. For example and similar to an approach gaining traction in the central banking community (Network for Greening the Financial System, 2020), since 2018 Banque de France has developed its responsible investment approach: in addition to excluding from its investments issuers whose turnover is linked to thermal coal and progressively aligning its portfolios with a trajectory compatible with the Paris Agreement, it also estimates the impact of its portfolios on biodiversity (Banque de France, 2023). By adopting

[13] For more information on the *Core Principles for Effective Banking Supervision*, please visit https://www.bis.org/bcbs/publ/d573.htm

[14] The analysis *Climate Scenario Analysis by Jurisdictions: Initial findings and lessons* (Network for Greening the Financial System & Financial Stability Board, 2022) found 35 and an additional 19 in progress by the end of 2022.

[15] See https://www.eba.europa.eu/legacy/risk-analysis-and-data/climate-risk-stress-testing-eu-banks/one-fit-55-climate-risk-scenario

sustainable and responsible investment policies, central banks can illustrate how investors can implement such an approach and gain a better understanding of the practical issues involved (Network for Greening the Financial System, 2024b).

Finally, central banks are also gradually incorporating climate-related developments into the design and implementation of monetary policy. The aim is both to take account of climate-related developments in macroeconomic models in order to better understand the impact of climate change on the structural dynamics of inflation and to adjust monetary policy operations to climate-related risks. Since 2022, the Eurosystem has been incorporating climate change considerations into its purchases of corporate sector securities, in particular by tilting asset purchases towards issuers with better climate performance.

5.2 Beyond financial supervisors, the public and private sectors have a role to play to catalyse the transition to a future-proof economy

Governments around the world are the primary actors when it comes to setting and implementing climate policies. While central banks and supervisors can contribute to the development of a climate-conscious financial system, their actions and those of financial institutions are only a complement to climate policies and cannot substitute or compensate for gaps in climate policies. Despite a likely overshoot above the 1.5 °C limit in the next decade, the 'well below 2 °C, if possible 1.5 °C' objective of the Paris Agreement must remain the long-term objective as reaching disastrous climate tipping points becomes more likely with every 0.1 °C and almost certain as we move closer to 2 °C. Business and consumers also need a clear view of regulatory evolutions and policy changes to be able to make informed investment decisions: as uncertainty is a significant cost and is undermining necessary action, governments should commit to clear and

credible transition policies that correctly assess and account for the impact of additional carbon emissions and communicate on clear and timely targets to anchor decisions by economic and financial actors.

Corporates and financial institutions individually and collectively progress towards a net-zero future by developing and disclosing their transition plans. Transition plans have the potential to become centrepiece in showing the real economy's pathway to a net-zero future. Through them, organisations demonstrate that they are committed to a 1.5 °C pathway, and that their business model will remain relevant in a net-zero economy. Supervisors, in coordination with standard setters, have a key role to play in ensuring that financial institutions design and deliver credible net-zero transition plans (Network for Greening the Financial System, 2024c).

Public and private actors must collaborate to mobilise more resources and bridge the climate finance gap, especially in EMDEs. While fiscal policies and finance from national and multilateral development banks are necessary, the transition effort cannot rely on public funding alone. Blended finance has the potential to crowd in private finance for climate mitigation and adaptation (Network for Greening the Financial System, 2023f). Synergising public and private capital through effective blended finance mechanisms can help de-risk private capital investments and scale up private climate financing more significantly. Finally, beyond the need for additional resources to finance the transition, public and private actors must phase out investments that are harmful for climate and nature.

6 Conclusion

Economies across Europe and Asia stand at a pivotal juncture where the integration of C&E risks into financial systems is not merely an option but a necessity. The insights and tools provided by the NGFS, particularly its climate scenarios, offer a comprehensive framework for assessing and mitigating these risks. By adopting the NGFS's forward-looking approach, European and Asian central banks, financial supervisors and policymakers as well as their peers in other regions can better understand the long-term implications of climate change and take proactive measures to safeguard economic stability.

The transition to a net-zero economy is within reach and brings significant benefits, including economic resilience and reduced climate-induced losses. However, achieving this transition requires accelerated and coordinated efforts from all sectors of the economy. Central banks can foster a financial system that enables the transition by integrating C&E risks into their missions, while the public and private sectors must strengthen their efforts and collaborate to drive systemic change.

Ultimately, the lessons from the NGFS highlight the critical need for international cooperation, strategic planning and ambitious action, in order to build a sustainable, future-proof economic landscape. By embracing these principles, Eurasian economies can navigate the challenges of climate change and unlock opportunities for sustainable growth and development.

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The Impact of the Magyar Nemzeti Bank's Green Mandate on Sustainable Growth

Dr Csaba Kandrács – Norbert Holczinger

The natural environment, the economy and the financial system are closely intertwined, compelling financial actors to address the environmental risk management and financing opportunities offered by green transition. Central banks should also not exclude themselves from the process, although they are far from being equally committed to sustainability at the global level. The Magyar Nemzeti Bank is one of the most active central banks in terms of sustainability; one key factor in this regard is that it has had a green mandate since 2021, as one of the first in Europe. The primary objectives of the measures taken within the framework of the Green Programme that was launched in 2019 with a focus on financial stability aspects and the Green Monetary Policy Toolkit Strategy that was announced in 2021 are to promote the green transition and improve the green financing environment as a key area in decarbonisation, thereby laying the foundations for environmentally sustainable growth.

Journal of Economic Literature (JEL) codes: E50, E58, N10, Q54

Keywords: central banks, climate change, sustainable finance, green financial regulation, sustainable growth

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1 Introduction

Climate change is one of today's most influential megatrends and has brought the importance of the natural environment to the fore. The interdependence of the economy and the environment is not a new concept (Meadows et al., 1972), but it was only in the last decade that the materialisation of environmental risks reached a level that has prompted decision-makers to act. Humanity has always had to deal with temperature fluctuations, extreme precipitation patterns and floods, but the frequency and intensity of these effects are increasing at a rate that threatens ecosystems. This process poses a risk to the economy as a whole, including financial actors. If we fail to reverse or slow down the current climate change trend, the physical effects of this change will be much more severe than those we are currently experiencing.

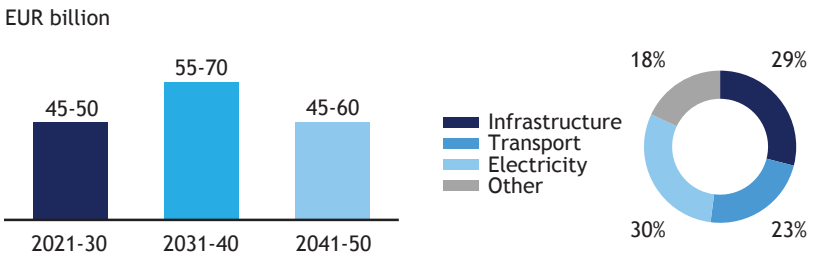
Mitigating climate change and its physical effects requires a radical shift in the way economic actors think and operate. Change, however, entails significant economic risks. These are so-called "transition risks" that arise from the transition to a low-carbon, climate-resilient economy. Reducing carbon emissions to net zero and implementing the necessary new technology will require radical environmental policy tightening in the economy, such as introducing emissions caps or taxes, or banning the use of certain polluting technologies. These measures drive human activities towards sustainability, but negatively affect some sectors, causing economic shocks. If these measures are implemented too quickly, there will be no time to adapt and companies might suffer heavy losses. As a result, similarly to physical risks, transition risks would have repercussions on the operation and profitability of companies and thereby on financial market operators. Therefore, it is clear that there are risks, but their level is uncertain.

As with most changes, the transition to the green economy presents not only risks, but also opportunities for economic and financial actors. The scientific community has now clearly

identified human activity, specifically carbon emissions, as the root cause of climate change. Consequently, the success of the sustainability transition hinges on drastically curbing carbon emissions. There are a number of estimates for the magnitude of this change in direction, at both the global and national levels. These include the calculations published to coincide with COP26, the UN climate summit in Glasgow, showing that a total investment of USD 125,000 billion in assets related to carbon-neutral energy and land use is required to achieve climate neutrality by 2050 (Vivid Economics, 2021). This is a massive sum, even when considering that, in addition to new resources, it also involves redirecting funds currently allocated to carbon-intensive assets. However, this figure is still well below the estimated level of losses caused by climate change, projected to reach USD 551,000 billion by 2100 (Tyndall Centre for Climate Change Research, 2018). Therefore, the sustainability transition is a rational direction in economic terms at the global level. When looking at smaller territorial units, however, the situation is not so clear-cut, due to the different characteristics of individual states and regions.

Hungary is among the fortunate countries that may be one of the economic beneficiaries of the green transition. Although the transition involves substantial costs (Ministry for Innovation and Technology, 2021; McKinsey & Company, 2022), several analyses have highlighted the potential economic benefits (Forbes, 2021; Bokor & Kim, 2021; McKinsey & Company, 2022). Over the next 25 years or so, investment needs totalling 2.5-3% of Hungary's annual GDP will open up vast financing opportunities for the financial sector.

Chart 1. Capital investment needed to achieve net zero emissions in Hungary



Notes:
Left chart: Total capital investment needed by sectors (2021-2050), 100% = EUR 145-196 billion.
Right chart: Other category: Buildings, Industry and Agriculture.
Source: Authors' compilation based on data from McKinsey & Company (2022)

2 Central banks and sustainability

It is apparent that there is complex interaction between the environment and the economy, with environmental changes affecting the economy and, in turn, the functioning of the economy having repercussions on the environment. The risks and opportunities arising from this interaction also have a major impact on the functioning of the financial sector. It is not surprising that central banks are also becoming increasingly active in the field of sustainability, although their traditional mandates include controlling inflation, ensuring the stability of the financial system and supporting the real economy (Dikau & Volz, 2021). However, these statutory responsibilities of central banks are also affected by environmental risks. The link with the financial system is perhaps the most obvious as the aforementioned physical and transition risks give rise to both macro- and micro-prudential concerns which are directly related to the activities of central banks and financial supervisory authorities. In addition, there is already empirical evidence indicating that other mandates

are also concerned, even in Hungary. It is sufficient to consider what happened in 2022 when energy prices skyrocketed to unimaginable heights, resulting in significant excess inflation and a soaring trade deficit (Kandrács, 2023).

Despite theoretical considerations and practical experience, there is no globally coherent approach to sustainability among central banks. As pointed out by Deák and Sárvári (2024), there is still no technical consensus, neither at the theoretical level nor in terms of the instruments at central banks' disposal. This is despite the fact that the top priorities of major international organisations which shape the trends in financial regulation, such as the International Monetary Fund and the Financial Stability Board, as well as organisations with major influence on the direction of global thinking, such as the United Nations and the Organisation for Economic Co-operation and Development, also include greening the financial system, supporting the transition to a sustainable economy, researching the negative impact of climate change on financial stability and mapping the possible responses to that impact (Kandrács, 2023).

The Magyar Nemzeti Bank (MNB) is in a special, if not unique, position as its statutory responsibilities cover the promotion of environmental sustainability. Indeed, in 2021, the Hungarian Parliament decided to add the green mandate to its existing mandates.[16] This was also a significant milestone at the global level as the Hungarian central bank was among the first in Europe to receive such a mandate. Thus, the MNB received the green light to contribute to environmental and sustainability objectives without jeopardising its primary objective (Magyar Nemzeti Bank, 2021). In other words, it became an explicit expectation for the Hungarian central bank to make its best efforts to integrate the

[16] Achieving and maintaining price stability and maintaining the stability of the financial system without jeopardising price stability, and supporting the government's economic policies.

environmental sustainability aspect into the thinking of financial actors.

However, the related work had already started earlier. In 2019, the MNB announced its Green Programme, driven by climate risk conditions in Hungary, their threat to financial stability and the lack of preparedness by Hungarian financial actors (Gyura et al., 2023). The MNB's analysis in 2019 showed that:

– Hungarian financial actors have significant exposure to environmental risks and are not adequately prepared to manage such risks; moreover, they do not take sustainability aspects into account in their day-to-day operations;

– the extent and quality of the systemic risks that may arise from sustainability and environmental risks is not known;

– instruments financing sustainability and green objectives are typically not available on the Hungarian market;

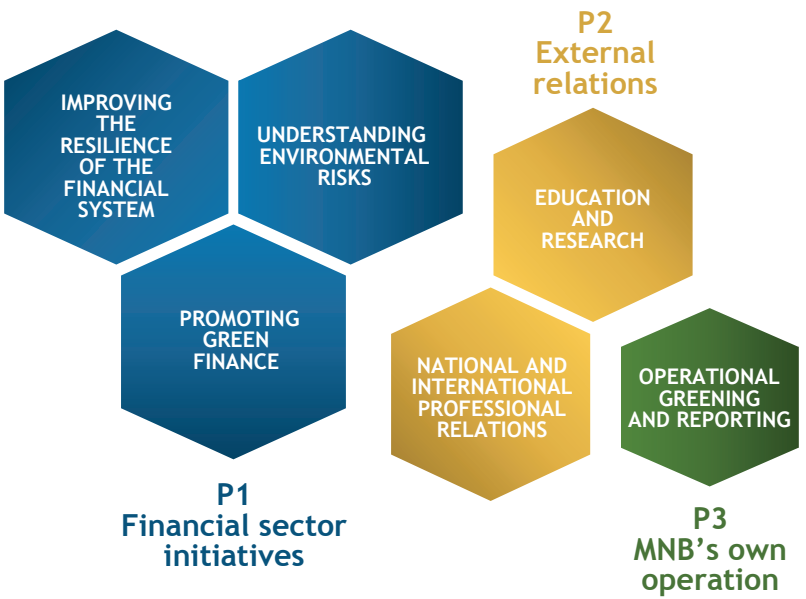
– decision-makers and financial professionals lack the expertise and knowledge to identify and manage risks.

The central bank was of the view that addressing these shortcomings was only possible through a comprehensive green strategy, namely the Green Programme.

The main objective of the Green Programme is to understand the link between environmental risks and the financial system. To this end, the programme takes a holistic approach, targeting not only financial actors, but also education and research activities as well as the MNB's own operations (Chart 2). Implementing measures aimed at financial institutions facilitates the development of a financial system that is resilient to environmental shocks caused by climate change and mapping financial risks associated with these shocks. In this context, and contributing to the transition to a green economy in Hungary, another key element of the Programme is the continuous improvement of the Hungarian green financing environment. Due to the complexity of the

sustainability issue and the importance of sharing experience, special focus was given to education and research, and on fostering relations both within Hungary and at the global level. In order to lead by example, the objectives of the Programme also extended to minimising the environmental impact resulting from the Hungarian central bank's operations and the full disclosure of financial and non-financial data related to climate change (Magyar Nemzeti Bank, 2019).

Chart 2. Pillars of the Green Programme



Source: Authors' compilation based on data from the Magyar Nemzeti Bank (2019)

In addition to the launch of the Green Programme, which is essentially a monitoring programme focusing on financial stability, it should be noted that the MNB also started to mainstream green aspects in its monetary policy and instruments. One tangible result is the Green Monetary Policy Toolbox Strategy announced in 2021, the year in which the green mandate was adopted. It examines possible directions for greening monetary

policy without compromising the fundamental monetary policy objectives of the instruments. The objectives of the Programme include assessing, evaluating and reporting on the climate exposure of monetary policy instruments. Moreover, in line with the Green Programme, the objectives of the Green Monetary Policy Toolkit Strategy also cover awareness-raising in society and strengthening green financial awareness.

In addition to these two strategy documents, the central bank's commitment to sustainability is also demonstrated by the focus on this issue in the MNB's supervisory strategy. Following the mid-term review of the document for 2020-2025 in 2022, sustainability is now not only reflected in the objectives, but also in the mission of the supervisory authority (Kandrács, 2022).

It is thus clear that environmental sustainability is given top priority in the Hungarian central bank's strategy. In addition to the aforementioned high-level documents, this is also supported by a wide range of measures taken by the MNB.

3 Measures taken by the MNB to promote sustainable growth

During the recent past, the MNB has taken a wide range of measures to promote environmentally sustainable growth in Hungary. The vast majority of these concerned the financial sector, but some were aimed at a broader scope of Hungarian companies.

3.1 Instruments to support environmental risk assessment and management

At the launch of the Green Programme, the scale of the challenges facing the Hungarian financial sector as a result of environmental risks was not clear. Identifying risks and measuring their potential impact are prerequisites for adequately managing such.

Accordingly, the MNB puts particular emphasis on measuring and assessing the financial risks associated with climate change and environmental degradation and on establishing a supervisory framework that takes these climate and environmental risks into account.

However, quantifying environmental (e.g. climate change-related) risks which materialise over a much longer time scale is far from being a clear-cut exercise. The solution may be to use stress testing, an approach that grew in significance after the 2008 crisis. This kind of testing examines the shock resilience of financial institutions in certain scenarios (Boros, 2020). Central banks have considerable experience in conducting stress tests; the MNB also regularly conducts such qualitative analyses at both the sectoral and individual institutional levels. However, previously modelled shocks are fundamentally different from the scenarios being modelled in relation to climate change. In addition to different time scales, the complexity of climatic events and their broad interaction with human activities also pose challenges. The most significant of these challenges is the time scale modelled over multiple decades as, in our rapidly changing world, capturing 10-/20-/30-year trends and their impact on financial entities requires the development of a new set of successive, long-term stress testing procedures. The MNB can be considered a pioneer in stress testing, having carried out a long-term exercise for the insurance sector in addition to the long- and short-term stress tests for the credit institution sector.

To assess climate risks, the central bank designed and ran a comprehensive, long-term climate stress test in 2021. The aim of the assessment was to model the impact of different climate scenarios on the Hungarian banking sector over the period between 2020 and 2050. The most important outcome of the analysis is the conclusion mentioned at the beginning of this paper: it was quantitatively confirmed that the green transition is in the interest of Hungary, both in environmental and economic

terms. Another key outcome of the long-term stress test is that it has highlighted the sectors that are most exposed to climate risks. The most acute increase in risks over this time horizon was identified for loans related to accommodation, hospitality and real estate transactions. Based on this, a failed sustainability transition would result in significant losses for the Hungarian banking system (Bokor & Kim, 2021; Forbes, 2021; Bokor, 2022).

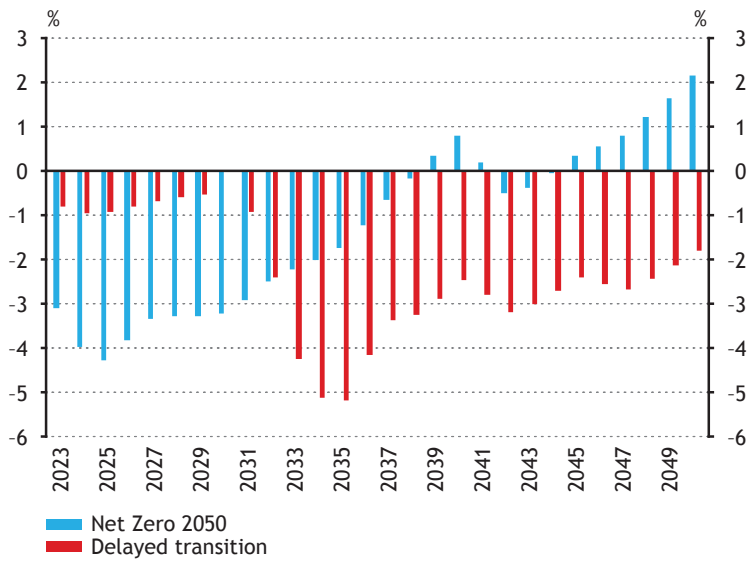
Following the long-term stress test, the central bank also ran a short-term exercise for the credit institution sector. As indicated, this time, modelling did not cover a 20- to 30-year time scale, but a much shorter period of 2 to 3 years. As pointed out by the Magyar Nemzeti Bank (2023a) and Várgedő (2022), this analysis was aimed at identifying transition risks based on a scenario analysis. In this case, the MNB quantified the impact of a carbon price shock, identifying the sectors vulnerable to this shock and its effects, credit transactions related to these sectors and credit institutions with the largest exposure to this type of loan. Due to the shorter time scale and different macroeconomic assumptions, the most affected sectors differed from those included in the results of the long-term stress test, with the energy and utilities sectors being the most at risk. Overall, this can be considered substantial, yet limited in extent as these exposures are not concentrated and loan portfolios are diversified in this respect. Therefore, in general, banks in Hungary are not exposed to significant risks.

As mentioned above, the MNB conducted stress tests not only for credit institutions but also for insurance companies. The latter are in a special position when it comes to climate change: they are exposed as businesses, underwriters, risk managers and investors at the same time (Deák et al., 2022; UNEP Finance Initiative, 2012). The MNB's analysis focused on their role as investors: the exercise covered the asset side of Hungarian insurance companies, quantifying the risks of transition to a carbon-neutral economy. In this respect, the approach is therefore similar to that adopted

in the short-term bank climate stress test. However, the modelled time scale was different as, in this case, the calculations covered the period up to 2050. The model was also similar to the long-term bank stress test in that it tested the effects of three climate scenarios.

The MNB modelled the shift in the yield curve for different climate scenarios with respect to the own assets of Hungarian insurance companies, which are dominated by Hungarian government securities. The results show that asset value will be the highest in the case of an orderly transition (net-zero scenario) (Chart 3), in line with the claim previously mentioned several times that the Hungarian economy could benefit from the green transition (Magyar Nemzeti Bank, 2023a; Tőrös-Barczel & Juhász, 2023).

Chart 3. Evolution of asset value compared to a failed transition



Source: Authors' compilation based on data from the Magyar Nemzeti Bank (2023a)

Quantifying climate risks is only the first step towards environmentally sustainable operation. There is also a need to evaluate the information received and incorporate it into decision-making processes and day-to-day operations. To this end, the MNB issued recommendations for three sectors by the end of 2023. In 2021, the credit institutions sector and, in 2023, the financial services and insurance sectors were informed of the MNB's expectations in relation to identifying, measuring, managing, controlling and disclosing environmental risks related to climate change. The central bank's recommendations cover institutions' business strategies, corporate governance, risk management systems and reporting practices. All three recommendations are aimed at ensuring that these sectors are prepared for the green transition and the associated regulatory requirements in both risk and business terms.

3.2 Incentivising sustainable finance

One direct reason for the launch of the Green Programme was the lack of green financial products in Hungary. It is therefore no coincidence that the MNB has also focused on the development of green finance in recent years, both through banking and capital market solutions.

In 2020, the MNB launched its Green Preferential Capital Requirement Programme which is unique at the global level so far. At its core, the initiative involves reducing credit institutions' Pillar 2 capital requirements for a given year for their green credit exposures. The Programme is primarily aimed at mitigating transition risks for credit institutions, while also promoting the uptake of green finance instruments and the development of green credit products.

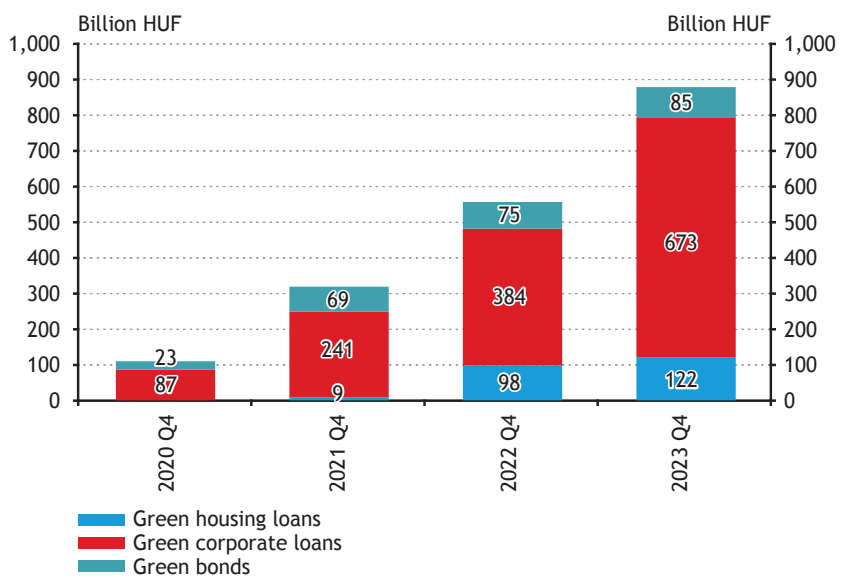
The rate of capital relief available for corporate, local government and retail exposures amounts to 5% or 7% of the exposures

eligible for the Programme (7% for full compliance with the EU taxonomy). However, based on prudential considerations, the rate of capital relief is limited, striking a balance between promoting the green transition and ensuring a robust capital position.

The Programme, which is voluntary, but is subject to data reporting requirements, was launched in several stages. Over the years, in addition to continuously expanding the range of exposures eligible under the Programme, its period of application has also been extended.

The range of exposures eligible under the Green Preferential Capital Requirement Programme grew dynamically. As of 31 December 2023, capital relief has been applied to bank exposures totalling HUF 881 billion. Of this, HUF 122 billion is housing loans and HUF 673 billion is corporate loans, while HUF 85 billion is green bond exposure (Chart 4).

Chart 4. Evolution of bank exposures under the MNB's Green Preferential Capital Requirement Programmes over time



Source: Authors' compilation based on data from the Magyar Nemzeti Bank (2024)

Corporate loans are dominated by financing for renewable energy production, with an 84% share. Other significant credit exposures include those related to commercial real estate (9.6%) and the purchase and operation of electric vehicles (3.6%). Retail loans were predominantly taken out for the construction and purchase of newly built, highly energy-efficient real estate.

In addition to the quantified results, it should be highlighted that programmes have had a market- and institution-building impact on the financial institution system as a whole. The programmes provided the basis for the establishment of green financing frameworks and the development of green financial products by Hungarian financial institutions. The latter can be seen, for example, in credit products for financing green home renovation and electromobility. In April 2023, the terms of the MNB's Certified Consumer-Friendly Housing Loans Programme were amended, allowing green home loans to be taken out at a wide range of banks without disbursement fees or energy performance certification costs.

Overall, the incentive introduced in late 2020 contributes to channelling financial resources into sustainable investments.

In addition to promoting green lending, it is also essential to mobilise the capital market to meet Hungary's climate and environmental targets as soon as possible. In order to develop the Hungarian green capital market, the MNB's Green Programme is complemented by a sustainable capital market strategy, for which the European Bank for Reconstruction and Development (EBRD) and Deloitte have been previously commissioned to develop so-called recommendations in support of an action plan.

In addition to greening supply, in both of its sustainability strategies the MNB has included the objectives of enhancing knowledge and raising awareness of green finance among consumers and the Hungarian society as a whole. Accordingly, the MNB launched its Green Finance Product Finder website in

April 2023. It is aimed at promoting the uptake of green finance instruments for environmental sustainability and improving their availability to the general public. The website allows for the comparison of investment products to enable retail investors to choose the right sustainable investment for their needs. When creating the application, the MNB took the relevant EU regulation as a basis to determine which investment products are considered sustainable:

– "an investment in an economic activity that contributes to an environmental objective …" (e.g. renewable energy; water management; waste management; reduction of greenhouse gas emissions; or biodiversity activities); or

– "… an investment in an economic activity that contributes to a social objective …" (e.g. investments that contribute to tackling inequality; investments that foster labour relations; or investments in human capital or economically or socially disadvantaged communities) [Regulation 2019/2088, Article 2(17)].

Sustainable investments must also meet other criteria, including that the investments should have no significant adverse impact on any of the objectives listed in the two points above and that investee companies should follow good corporate governance practices (Magyar Nemzeti Bank, 2023b).

The site also features green investment funds, unit-linked life insurance asset funds and, also in the spirit of long-term self-provision, various voluntary pension fund portfolios. In Hungary, there is only one single ESG (environmental, social and governance) focused voluntary pension fund portfolio so far, but more are expected to come in the future. The reason is that highlighting domestic green finance instruments can also act as an incentive for financial actors, promoting the development of additional forms of sustainable finance as early as possible (Deák & Jókuthy, 2023).

3.3 MNB's green monetary policy steps to create green mortgage lending

As part of the Green Monetary Policy Toolkit Strategy launched in autumn 2021, several initiatives have been implemented to strengthen sustainable financing in Hungary. These included two programmes to support the energy upgrade of the Hungarian housing stock with high energy demand. The Green Mortgage Bond Purchase Programme was aimed at establishing the Hungarian green mortgage bond market and, in addition, increasing green mortgage bond issue. The initiative indirectly supported the uptake of green mortgage loans through targeted purchases. The Programme provided incentives to commercial banks to consider the energy performance of properties in their mortgage lending practices. In addition to positive effects on product development, the Programme also enhanced transparency by requiring issuers to disclose the energy performance of properties used as collateral for mortgage bonds and mortgage loans used as security. Furthermore, issuers were required to commit to provide information to their customers on the contribution of consumer mortgages to environmental sustainability objectives.

In addition to purchasing green mortgage bonds, the MNB launched an initiative to stimulate green lending appetite more directly. Launched as part of the Funding for Growth Scheme (FGS), the Green Home Programme was a refinancing tool to create green home lending in Hungary by developing a Hungarian housing stock with a healthier structure. In the Green Home Programme, the MNB provided banks with a refinancing facility at 0% interest to relend to retail customers at an interest rate of up to 2.5%. The Programme provided affordable financing for the construction or purchase of energy-efficient and green residential properties with an energy rating of BB or better and a primary energy demand of up to 90 80 kWh per m^2 per year or subsequently 80 kWh per m^2 per year. Thus, the FGS Green

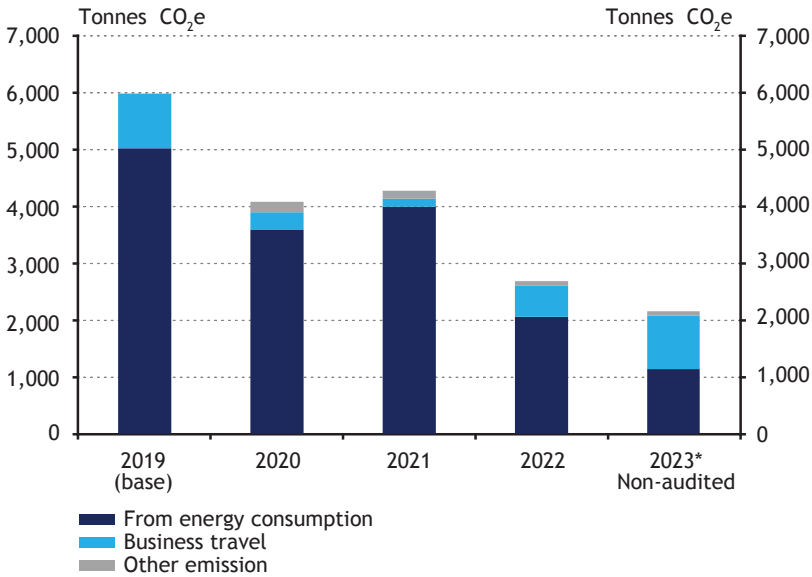
Home Programme provided favourable conditions to facilitate the creation of a green housing loan market and the mainstreaming of environmental sustainability considerations in the housing market, while the MNB fully sterilised the liquidity issued under the Programme. With a total budget of HUF 300 billion, the Programme contributed to the construction and purchase of nearly 9,000 energy-efficient properties (Magyar Nemzeti Bank, 2023a).

3.4 Leading by example in operations

The MNB also seeks to be at the forefront of eco-sustainable operations when it comes to its own operations. The central bank is constantly making efforts to minimise the environmental impact of its operations. In its environmental strategy for 2020-2022 (Magyar Nemzeti Bank, 2023c), the Bank committed to reducing the carbon footprint of its operations by at least 30% by the end of 2022 as its key target. This target has been met and even exceeded: the per-capita carbon footprint of operations has been reduced by almost 60% (Chart 5). The MNB compensates for emissions that can no longer be reduced by funding habitat restoration programmes. Nature-based projects have a number of benefits contributing to the conservation of biodiversity through the ecosystem services they provide.

The example set by the MNB can inspire not only financial institutions but also a wide range of companies to operate in a more environmentally conscious way, thereby contributing to Hungary's decarbonisation targets.

Chart 5. Evolution of the MNB's operational carbon footprint



Source: Authors' compilation based on data from the Magyar Nemzeti Bank (2024b)

4 Summary

The natural environment and the economy are closely intertwined: changes in the environment affect the economy, while the functioning of the economy has repercussions on the environment. The financial system cannot exclude itself from this interaction and is compelled to address both the management of environmental risks and the financing opportunities arising from the green transition.

The involvement of central banks in sustainability has intensified in recent years, but there is still no uniform approach at the global level. Some central banks are actively addressing the issue beyond their traditional mandates, while others put less emphasis on it.

The MNB is in a unique position as it is among the first European central banks to have a green mandate since 2021, addressing environmental sustainability based on direct legal requirements. However, the Hungarian central bank recognised the importance of this issue even before its green mandate and established its Green Programme mainly with a financial stability approach. Announced in 2019, this strategy applies tools that are innovative even at the global level, such as green recommendations for financial institutions or the Green Preferential Capital Requirement Programme. The measures implemented under the Green Monetary Policy Toolkit Strategy announced in the year of the award of the central bank's green mandate have contributed, among others, to the integration of sustainability considerations into Hungarian mortgage lending and the establishment of the Hungarian corporate green bond and green mortgage bond market. Therefore, both strategic programmes strongly build on measures aimed at improving the green finance environment, a key area for sustainable transition and decarbonisation.

However, a successful green transition requires more than ensuring the availability of financial resources: it also requires improving sustainability knowledge and raising awareness of best practices among stakeholders. Therefore, it is no coincidence that the MNB places great emphasis on education and scientific cooperation. Moreover, through its own operations, it aims to set an example to economic operators by promoting the achievement of climate targets through a combination of reducing the environmental impact of its operations and compensating for the remaining emissions.

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Sustainable Development Policies: Economic, Social and Environmental Facets

Seck Tan

This paper concentrates on development policies that incorporate economic, social and environmental facets. Economic growth improves economic performance with natural endowments, such as land and resources, whereas economic development enhances liveability with education and employment. Growth hinges on the extraction of finite resources to advance the economy, whilst development works with extracted resources to maintain a standard of living. For development to be truly sustainable, growth must be inclusive and demands an equal focus on economy, society, and the environment. To continue growing, economies skew towards economic performance with a conveniently oblivious attitude towards the environment. As the environment is both a source and a sink, there must be a deliberate attempt to treat the environment as capital in macroeconomic modelling. Thus, effective sustainable development policies must clearly differentiate between economic growth and economic development. The social facet in sustainability is often boldly illustrated in the context of island states as these nations may not have the capacity to embrace much needed development requirements due to limitations in economies of scale and isolated locations. With limited endowments, island states must rely on finite human capital for growth, whilst development policies must carefully consider the utilisation of employable labour force. Based

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on a macroeconomic model, economic, social and the environmental facets are briefly discussed as well as the implications for sustainable development policies.

Journal of Economic Literature (JEL) codes: B22, E12, E63, O44, Q01, Q56

Keywords: economy, environment, macroeconomic stabilisation policies, society, sustainable development, policy implications

1 Introduction

John von Neumann (1903–1957) was a mathematician with notable contributions in the fields of economics, physics and statistics, as well as game theory (Von Neumann, 1928) and quantum physics (Von Neumann, 1955; 2013) in particular. In a 1937 theoretical publication (Murray & Von Neumann, 1937), a mathematical model was used to explain a growing economy. As this was a theoretical piece, it was understood by few and had minimal influence on policymaking, thus explaining the publication's relative influence (Frank, 2023). A decade after the work of Murray & Von Neumann in 1937 on game theory, Von Neumann & Morgenstern (1947) featured a solution developed to address a question and was certainly applicable in World War II and Soviet Union atomic threat. Subsequent application to quantum physics led to the Von Neumann entropy, which was a development from classic to quantum statistical mechanics. These are just some of the wonders of Von Neumann's mathematical talent. Hemmo and Shenker (2006) suggested that the Von Neumann entropy (Von Neumann, 1955) does not correspond to thermodynamic entropy. To date, there have been few who supported this non-correspondence, and the entropy of energy levels is the essence for the discussion on sustainable development in this study.

Sustainable development may be explained by the two laws of thermodynamics. The first law of thermodynamics states that matter cannot be created nor destroyed; it can only be re-arranged (Wagner, 1891; Guggenheim, 1985). Matter is re-arranged as the ecosystem provides material for energy input and absorbs waste. The second law is when energy is transformed from a state of low entropy (high energy) to a state of high entropy (low energy) to do work. The combination of these two laws results in an absolute scarcity of resources (Daly, 1991), and such scarcity implies that the ecosystem must be used in an efficient manner to allow for sustainability – an interaction of economy, society and the environment. To continue growing, economies skew towards economic performance with a conveniently oblivious attitude towards the ecosystem. However, when consumption and production waste exceed a threshold, externalities result in various forms of pollution, such as air, noise and water pollution.

There are two broad ways to address negative externalities: i) setting a price for pollution; and ii) setting an acceptable volume of pollution. In the first case, pricing in the form of a Pigouvian tax (Pigou, 1920) is imposed on pollutants of negative externalities so that pollution levels adjust to a socially optimal quantity. In the second case, pollution levels proxied by corresponding property rights by the Coasian approach (Coase, 1960)[17] determine how much pollution the society can accept. Thus, tax rates set a price and property rights set a permittable quota with both initiatives at a local government's discretion. To accurately determine an equilibrium price and quantity that minimises social costs, local government must rely on effective market mechanisms. However, due to the nature of the good (externalities) in question, there is no known market as there is only market failure. Markets created in this nature argue for an equilibrium price and quantity is artificially created for polluters themselves to pay out of guilt.

[17] Coase's paper challenged Pigou's analysis of externality where property rights can be assigned to parties who value it most.

Instead of reviewing the level of pollution, a binary argument is to look at how much available inputs there are and proxy these inputs as a form of capital so that their utilisation can be valued. But even so, there is no universally agreed approach to accepting the measurement of the inputs' utilisation.

This paper highlights development policies that incorporate economic, social and environmental facets. Economic growth improves economic performance with natural endowments, such as land and resources, whereas economic development enhances liveability with education and employment. Growth hinges on the extraction of finite resources to advance the economy, whilst development works with extracted resources to maintain a standard of living. For development to be truly sustainable, growth must be inclusive and demands equal focus on the economy, society, and the environment. As the environment is both a source and a sink, there must be a deliberate attempt to treat the environment as capital in macroeconomic modelling. The social facet in sustainability is often boldly illustrated in the context of island states as these nations may not have the capacity to embrace much needed development requirements due to limitations in economies of scale and isolated locations. With limited endowments, island states must rely on finite human capital for growth, whilst development policies must carefully consider the utilisation of employable labour force.

Thus, effective sustainable development policies must clearly differentiate between economic growth and economic development. The next section details with macroeconomic stabilisation policies for market equilibrium. This is followed by a careful examination of sustainable development and the implications for economic performance and sustainability based on a macroeconomic model. The study then concludes with a discussion of the implications for sustainable development policies in the island state of Singapore.

2 Macroeconomic stabilisation policies

The standard macroeconomic model of aggregate demand and aggregate supply (AD-AS) analyses economic fluctuations for most economies. Aggregate demand (AD) is the quantity of goods and services that households, firms and the government would want to buy at each price level. Aggregate supply (AS) is the quantity of goods and services that firms would choose to produce and sell at each price level. AD and AS are combined to determine the equilibrium level of output and price for an economy, and economic performance is measured by the rate of growth of output. Policymakers would also be interested in the levels of unemployment and inflation in the same time period, in order to avoid any macroeconomic imbalances. The levels of output, unemployment and inflation are key indicators that determine the health of an economy. Based on the AD-AS model, there are three basic macroeconomic policy areas of intervention: the level of aggregate output, unemployment and inflation.

In the short run, unemployment can result from either a downward shift of AD (assuming negative sloped) or an upward shift of AS (assuming positive sloped). In the long run, unemployment is dependent on the production capacity of an economy. If there is no spare capacity, unemployment will rise with no allowance for further employment. Both unemployment and inflation are interdependent indicators as they relate to the fundamental question of macroeconomics, i.e. the aggregation of economic activity. In other words, unemployment and inflation determine the extent to which resources are used for aggregate output in relation to potential output. Ideally, an economy should have zero unemployment and inflation in a range between 2–3%. But the reality remains where unemployment and rising prices exist in all economies. Overly high inflation will not be tolerated by central banks, and measures will be taken to curb inflation by

slowing output growth and raising economic capacity. Therefore, targeting inflation is one approach to maintaining price stability.

The deliberation between short and long run as per Keynes (Quiggin, 2019) points to the importance of focusing on short runs as cyclical changes of depression and recession may demand more of stabilisation policies. After all, many short runs make up the long run. As long as unemployment is at an acceptable level and inflation is within a targeted band, both macroeconomic indicators can be managed with intervention. And a stable macroeconomic environment with stabilising policies can guide output growth and predictive price changes. There are stabilising policies that governments can undertake to manage AD (Stegman & Junor, 1993) during periods of high unemployment and/or high inflation, which serve to avoid an economy operating at close to its productive capacity and with inflationary pressures. For instance, when tax revenue is reinvested in the infrastructure of an economy, AD will increase due to increases in investment in the short term. However, the returns for an economy will only be felt in the longer term, when the capacity of the economy is increased.

Intervention is not always necessary as there are automatic stabilisers that can also stabilise an economy. These counter-cyclical effects are a result of fluctuations in the economy with no government intervention. When real output increases, government expenditure will decrease, and tax revenues will increase. As an illustration, a fall in unemployment from increased output reduces benefits spending, and this reduces the budget deficit during economic expansion. A higher level of employment is likely to yield a greater level of tax receipts and lower government expenditures. Economic growth is likely to be controlled as AD is likely to be reduced, thus minimising the risk of inflation. However, automatic stabilisers may not be as effective as previously thought because consumer expectations and business expectations may change. External economic influences may lead

to changes in expectations, especially if uncertainties and risks exist.

Alternatively, the government (economy) can rely on the central bank to use monetary policy to address economic stability. This is an indirect intervention using interest rates primarily to target inflation. There must be a right amount of monetary stimulus or restraint as well as strong governance of the central bank which is assumed to be the institution which sets the interest rate. This assumption is critical as Taylor & Williams (2009) found that macroeconomic models of monetary policy evaluation could not reconcile the spread between central banks' interest rates and market interest rates set by commercial banks. Frank & Bernanke (2009) proposed that to make sensible policy, central banks must have an idea of the inflation rate they would like to achieve. Similarly, Chari et al. (2009) echoed that some form of inflation target with well-defined escape clauses is what most macroeconomists are comfortable with. The success of monetary policy depends on the policymaker's commitment and on keeping both interest rates and inflation low on average.

However, if the shock is of a supply side nature, monetary policy will not help with addressing unemployment because policies dealing with labour supply and productivity do not fall within the jurisdiction of the central bank. A fiscal-monetary mix can also be used, depending on the relative strength of the fiscal and monetary policies and their effects on the different sectors of the economy (Samuelson & Nordhaus, 2001; 2009). Thus, to manage AD fluctuations, fiscal and monetary policies or a combination of a fiscal-monetary mix can be used to keep AD and output in equilibrium. When an economy is at its natural rate of unemployment, policies will have marginal or no influence on employment. Such interventions can only result in inflation (in the long run), generating further inflationary pressures. Given that the level of aggregate output is explained in reference to the natural level of output determined by the productive capacity of

the economy, it is important that the productive capacity of an economy be correctly determined.

3 Sustainable development and implications for economic performance

Sustainable development [as defined by Brundtland et al. (1987)] points to development that meets the needs of the present without compromising the ability of future generations to meet their own. But economies need to first grow in the short run to have the capacity for subsequent development in the long run. Economic growth is expanding the community with natural endowments, such as land and other resources, towards a better standard of living via improved economic performance. On the other hand, economic development enhances liveability for instance, culture and heritage, education, employment and community development. Furthermore, growth relies on extracting finite resources to advance an economy, whilst development works with resources that have already been extracted to maintain a standard of living. Thus, growth is not sustainable but rather it is development that is sustainable. Kolstad & Krautkraemer (1993) pointed out a dynamic link between the environment, resource use and economic activity. While resource use yields immediate economic benefits, it has a negative impact on the environment but this downside is observable only in the long run.

The productive capacity of an economy is dependent on the production process. The production function in most economic textbooks (Antonovics et al., 2015; Begg et al., 2014; Dornbusch et al., 1995; Frank, 2003; Pindyck et al., 2006; Mankiw et al., 2008; Blanchard, 2009; Frank & Bernanke, 2009; Blanchard & Sheen, 2013; Frank et al., 2021) considers labour (L) and manufactured

capital (KM) to be the only factors of production.[18] The price of labour is the wage paid for each unit of labour, and the amount of labour can be determined through demand and supply in the labour market. KM refers to goods used in future production, and they can be priced as rent assuming they are not owned with a fixed supply. With technological advancement, rent can be discounted for depreciation. Thus, both L and KM can be easily priced (and amortised) through their respective markets. However, production does not rely solely on L and KM, but also on the natural environment. For example, air, land and water are essential requirements for any production process. Thus, development cannot be sustainable without considering finite natural resources in the production function.

There are a few authors who have considered the natural environment as a production input. Frank (2003) discussed natural resources as inputs in production. The discussion was focused on the awareness of renewable and exhaustible (non-renewable) resources, and the transition from exhaustible to renewable energy sources. Frank's collaboration with Bernanke and other scholars in later textbooks (Frank & Bernanke, 2009; Antonovics et al., 2015; Frank et al., 2021) presented the production function to include technology and land though the numerical illustration focused only on L and KM. Mankiw et al. (2008) included L, KM, natural resources and technology in their production function. Akin to Frank & Bernanke (2009) and Frank et al. (2021), the numerical illustration focused on L and KM subject to their returns to scale. And as per Frank (2003), their natural resource discussion was limited to renewable and non-renewable resources.

Most authors discussed the natural environment, but did not proceed further to incorporate natural resources into

[18] The contention here is that historical and traditional models of production do not place an emphasis on the natural environment, and this has resulted in economics teaching at higher levels of learning that offers no consideration of the environment as capital when an economy grows.

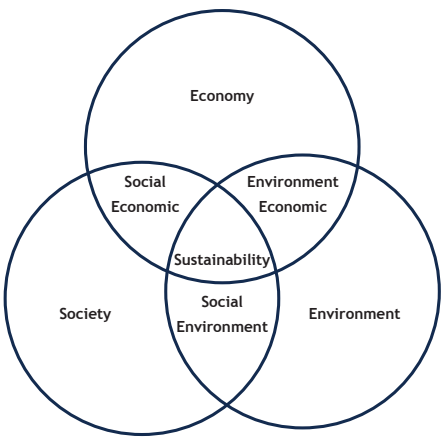
the production function. Their discussions stopped short of accounting for natural resources and attributed economic growth to non-resource factors. Although resources are recognised as a necessity for production, the quantity of resources used can be small because L and KM can be substituted in sufficient quantities. Perhaps, a justifiable analysis of the natural environment as inputs in production was made by Samuelson & Nordhaus (2001; 2009). They divided factors of production into three categories: land, L and KM. Land and L are the primary or original factors of production. Land can be a derived demand as it depends on the product produced. KM was added only as the produced factor of production and can be categorised as structures, equipment and inventories. But nature (as well as capital and labour) is capital and includes land, forests, fossil fuels and minerals as a wealth asset (United Nations, 2012). Therefore, investments towards production should consider natural capital as a factor of production.

If the production process takes into consideration the natural environment, using up more of the environment capital will reduce the capacity of an economy. The economy will contract, resulting in higher unemployment at current market wages. This overstates the capacity of an economy as the true capacity of the economy has been appreciated (Thampapillai et al., 2005). In turn, this will generate inflationary pressures as there are fewer resources to go around within the economy. Inclusion of environmental capital in the standard macroeconomic framework (Thampapillai, 1993; Thampapillai & Hanf, 2000; Tan, 2016) might generate higher unemployment and higher prices leading to a reactive policy response to close the gaps relating to output, employment and inflation. A key determinant for formulating stabilisation policies would be the difference in the magnitude of the gaps when the environmental-macroeconomics (EM) framework is adopted as opposed to the standard macroeconomic framework (Thampapillai et al., 1998; Thampapillai, 2007; 2008; Tan, 2024).

4 The economy, society and the environment

It was five decades ago that Georgescu-Roegen (1970; 1971) and Daly (1977) argued that more economic growth would entail more production and consumption activities to satisfy human wants. Growth is dependent on the extraction of finite resources to advance an economy, whilst development works with resources that have already been extracted to maintain a standard of living. Once growth is allowed to progress beyond sustainable development, there will be two immediate trade-offs, which demonstrate the close-knit relationship between economic activities and the natural environment: 1) regeneration of the renewable natural resources of an economy; and 2) the environment's assimilative capability of waste absorption. Sustainable development is where virgin natural resources are no longer necessary for the progress of an economy (beyond economic growth). However, sustainable development denotes different perspectives to different audiences; and for development to be truly sustainable, growth must be inclusive and demands equal attention to the economy, society and the environment.

Figure 1. The economy, society and the environment



Source: Own work

In Figure 1, sustainability is illustrated by the interactions between an economy, its society and the environment. The economy encapsulates all of the activities related to growth, output and employment; the environment refers to natural resources and its function as a sink and a source; whilst society is about the community and inclusivity. There are also interfaces between the economy and society (social equity with strong business ethics), the economy and the environment (sustainable economy with environmental economics), and society and the environment (local environmental stewardship). It would do little justice to have a discussion between each of the twin interfaces of the economy and society, the economy and the environment, and society and the environment in this space as they entail layers of understanding which warrant another study. Earlier sections of this paper offered interactions between the economy and the environment.

The next section focuses on the societal facet with proxy to human capital and reference to the island state of Singapore.

5 Implications for policy/ies

The social facet in sustainability is often boldly illustrated in the context of island states as these nations may not have the capacity to embrace much needed development requirements due to limitations in economies of scale and isolated locations. With limited endowments, island states rely on finite human capital for growth whilst development policies must carefully consider the utilisation of employable labour force. And based on a macroeconomic model by Tan (2016; 2024), in which employment, the labour force and labour force participation are used as indicators for L in a traditional production function, it was found that sustainable development policies must also consider the public, which includes the labour force (as a factor of production) and as a finite resource. With reference to the

island state of Singapore, this section charts the progress of its environmental policies and highlights the strategies embraced for environmental sustainability with public engagement. A brief introduction of the island state ensues, followed by the progress of its environmental policies, and the environmental strategies completes this section.

5.1 Singapore as an island state

Singapore is an island state in Southeast Asia nestled amongst a mix of Association of Southeast Asian Nations (ASEAN)[19] neighbours rich in culture and ethnicity and is part of the greater Asian[20] region. When it comes to economic survival, there is no significant difference between island states and global economies. Faced with threats from sea-level rising and natural environmental hazards, islanders are instinctively resilient with strong migratory capabilities. Pristine forests and mountains, sandy white beaches, alluring atolls and crystal blue waters are just some island attractions. However, beyond these natural luxuries lie the harsh realities of environmental issues, such as water crisis, poverty, health pandemics, financial crisis and obstacles to economic growth that are no different to those faced by most economies; see Nurse et al. (2001) and Duncan (2011). Singapore is no different from other island states and it is not immune to extreme events. The impacts of extreme events are systemic and affect all aspects of the society and these shocks are more impactful than is currently acknowledged (Tan & Lai, 2016).

Sustainable development points to the importance of economic, societal and environmental well-being in public policy formulation. Singapore is an island state, with a limited land area

[19] The 10 ASEAN nations include: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

[20] Asia is made up of 50 countries (https://www.countries-ofthe-world.com/countries-of-asia.html) which includes the Southeast Asia region.

and natural resources and with labour as its main source of capital. It has been labelled an island state with no alternative energy sources, and this inadequacy has shaped environmental policies skewed in favour of economic development. The ease of evading environmental responsibility is subject to what is communicated about energy sources. Historically, the island state's position on environmental policy suggested that there were major obstacles to switching to renewables and reducing fossil fuel dependence. Coupled with traction from accumulated advancements in energy conservation, the scope of emissions reductions is further restricted for a comparatively smaller economy. These set the trend for (unsustainable) environmental policy as island states remain vulnerable to natural hazards of the environment as well as to regional phenomena.

5.2 Charting progress

Environmental protection was secondary as economic development was the priority in past decades. But the island state cannot have it both ways, accepting that economic development impacts the environment and continuing to implement policies with no consideration of the environment. Environmental policies that are pro-development could negate Singapore's economic progress in the long run; thus, policies must offer appreciation to the environment to recognise sustainable development. There are two explanations to why environmental protection is overlooked with preference to economic development, namely economics and regulation. In terms of economics, decision-making is bounded by costs and ruled by perceived benefits overriding any impacts on the environment; as is the case of assessing the cost-effectiveness of alternative energy sources (Hamilton-Hart, 2006). The second explanation is regulatory, which concerns the application of an Environmental Impact Assessment (EIA). Studies have found the EIA to be a useful tool in administering environmental policies (Perry & Teng, 1999) but the EIA is limited in Singapore as it is

deemed to inconvenience the promotion of development (Chua, 2005) and economic growth.

International trade has elevated the status of Singapore, but studies (Lopez, 1994; Harris, 2004; Frankel, 2009) have found that global trading can result in environmental degradation. Singapore's favourable geographic location offers a unique value proposition though at the same time it sets the island state at the mercy of the international system, over which it has limited control (Connell, 2013). In addition, Singapore's geographic location in the ASEAN region suggests that it plays no more than the role of a tacit taker when regional environmental natural hazards and extreme events occur. Singapore has explored alternative growth and development paths where environmental mindfulness has provided commercial prospects for sustainable industries. This environmental stewardship has advanced upstream employment, empowered labour resources and branded a cleaner proposition.

5.3 The environmental strategies

An EIA is a detailed study which analyses and assesses the type and extent of impacts that a proposed project would have on the natural environment. Such an assessment would enable decisionmakers to take informed action with an awareness of the positive and negative consequences for the environment from a holistic study. An EIA is typically undertaken before a decision to proceed with a development project, before a final decision is made by project stakeholders. The aim of the EIA is to ensure that decisionmakers are well-informed about the environmental impacts when the project proceeds. In summary, an EIA serves to: i) determine if the impacts can be accepted or be addressed; ii) propose mitigation measures; and iii) recommend alternative feasible options to incorporate mitigation measures.

Between the 1960s and the 1980s, developments in Singapore were excused from EIAs and decisions were made with loose assessments to ascertain if a project was appropriate for a particular location, although Hesp (1995) discusses that the EIA process was carried out in secret or when the government deems it to be required. It was not until 1989[21] when the EIA was formalised and made necessary for all new projects. For example, before a developer carries out a project, a proposal must be forwarded to the Pollution Control Department for an initial assessment to determine if an EIA is required (Tan, 1993). It was highlighted that Singapore practices a discretionary EIA rather than a mandatory EIA (Chia, 1998). And to not adopt a compulsory EIA, the island state must present well-conceived physical plans to enable economic development whilst at the same time stipulating environmental safeguards. Considering that Singapore's coastal zones have undergone complete transformation through land reclamation, construction of air and seaport, amalgamation of small islets into larger islands, and the removal of coral reefs and mangroves, Chia (1998) recommended that an EIA be mandatory for environmentally fragile areas.

An EIA process should be invoked in the initial stage of any planning or development proposal (Hesp, 1995) incorporating public participation and reviews. The purpose of public consultation is to explain the nature of the proposal to the public, allowing stakeholders to understand the public's opinions of the proposal and incorporate these into the assessment. Nonetheless, there remains no (or minimal) public consultation and EIAs are not freely available to the public in Singapore (Hesp, 1995). There is reservation that even with public consultation, it is unlikely that the views of the public will be taken into consideration[22] and that

[21] The *Clean Air Act* of 1971 and *Water Pollution Control and Drainage Act* from 1975 allowed an EIA to be imposed.

[22] Please see http://blog.nus.edu.sg/wildlifereverse/2015/03/18/environmental-impact-assessment-eia-for-developers/

the EIA is merely a process to fulfil a requirement towards project advancement with informed decision-making. But this reservation is unfounded because the development can still proceed with mitigation measures in the event that there is strong opposition to a proposal. Singapore was ranked poorly on environmental protection (Bradshaw et al., 2010), but measures have been taken to safeguard the environment. This has come in the form of an EIA analysis where the environmental impacts of a project or development are studied and the public is given an opportunity to provide feedback. Please refer to cases highlighted in Tan (2017; 2018) where there was significant progress in environmental awareness for an island state which has placed economic growth on a pedestal since independence.

Singapore has offered human capital services (Tan & Shevchenko, 2016) to the ASEAN region (and beyond) and this transfer should also include sustainable development options. To consolidate Singapore's role as a leading island state, it has led in sustainable initiatives which allow economic development to occur within fragile environmental boundaries and threat of extreme events. Singapore companies (Sembcorp Industries, Banyan Tree Hotels & Resorts, Senoko Energy and Singtel) have taken the lead towards sustainable development and addressing climate change. Select projects to boost productivity include lowering transportation cost, improving energy availability, enhancing communications networks and distributing clean water. These will maintain the competitive edge of Singapore and ensure continued demand for technical know-how from its human capital. The evidence of EIA cases is a clear indication that care is being shown to the environment when considering development (that drives economic growth). Environmental strategies require human capital inputs to develop, operationalise and police the policy initiatives.

6 Conclusion

This paper started with a discussion of effective sustainable development policies hinging on the differentiation between economic growth and economic development. The second section makes reference to market equilibrium with macroeconomic stabilisation policies. A detailed analysis of sustainable development and its implications for economic performance was presented, before the sustainability facets of the economy, society and the environment were examined. An illustration of the island state of Singapore with its human capital as natural resources concludes the paper, with the implications on charting and progressing its sustainable development policies.

The idea of sustainability has a long history, even though its vocabulary is just three decades old (Thiele, 2016). It is little wonder that Thiele's book (2016) targeted students and built on Stone's work (2010) that students are part of the natural world who will protect and maintain the environment as the rightful future owners. Akin to Murray & Von Neumann's theoretical piece (1937) which was understood by few (Frank, 2023), this paper serves to present an intricate and yet uncomplicated relationship across the three facets for sustainable development policies. Coupled with contextual policy recommendations, it is hoped that this study can help influence policymaking to move towards sustainable development.

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Chapter 2

Competition for Sustainability – Sustainable Competitiveness

The Key to Cities' Competitiveness: Future Readiness

Dr Bruno Lanvin

Cities are our future. This was true before the shocks of the early 21st century (the SARS epidemics of 2002–2004, the financial crisis of 2008–2009, Covid in 2021–2022) and the resurgence of geopolitical tensions. This now takes on renewed strength and relevance as we enter a so-called post-globalisation era. As uncertainties continue to grow, cities have often been picking up the ball where nation states left it. By taking on new responsibilities and adopting innovative ways to address long-standing and emerging problems, cities are also striving to become future-ready, opening up new possibilities to reshape the international order 'from the ground up.'

Focusing on five key areas (health, the environment, investment, innovation and talent), this paper shows how certain, city-specific strategies have outpaced those of their respective nation states. Approaches to these five critical areas have been revisited by spearheading cities (often smart cities*), and practical examples are offered of how some of them have tackled (1) health emergencies, (2) climate emergencies, (3) investment attraction, (4) innovation ecosystems development and (5) talent attraction and retention.*

The paper also identifies ways in which cities are articulating their future readiness strategies, and how their efforts to do so contribute to shape the post-global economy that the world is now entering. The key point is that future-ready cities are emerging as a harbinger of post-globalisation.

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Although larger cities will likely continue to lead the way in a number of areas, a significant number of second-tier cities *(typically with populations between 100,000 and 1,000,000) have started to emerge as magnets for investment and talents, and as sources of best practices in efforts to be 'green and digital' in particular.*

Three key examples are presented: Budapest, Shanghai and Singapore. Because of their differences and specific personalities, these three cities demonstrate how a Eurasian context could help foster current progress.

The paper concludes with a call for action, encouraging cities to take on growing responsibilities in shaping a desirable future, in particular by (1) staying aware of what technology can bring to addressing long-standing problems in novel ways; (2) being human-centric; (3) being open to trade, investment, innovation and talent flows; and (4) including younger generations in their efforts and governance.

Journal of Economic Literature (JEL) codes: F21, H70, O18, R11, R12

Keywords: post-globalisation, cities, smart cities, competitiveness, future-readiness

1 Introduction

Intuition and common sense might suggest that international relations are exclusively (or mostly) about relations among nations. In reality, any connection between at least two players operating in two different national spaces is international by nature. In today's world, some analysts may have been a bit too fast in identifying the demise of globalisation. If anything, globalisation may be growing even stronger, due to a tighter and more complex meshing of interactions among a larger array of players. In this context, nation states may be losing ground and prominence (due to the disintegration of multilateral disciplines, and more generally to the rise of nationalistic and protectionist

attitudes),[23] but cross-border activities by other entities (typically private businesses, but also cities) have grown in inverse proportion over the recent period.

In a number of domains, cities in particular have proved that they can be more agile, more innovative and more open than most nation states (often including their own). By moving closer to centre stage, cities have been drawn into a vortex of complex forces which was not previously part of their traditional environment. They had to learn to become global competitors, to design and adopt innovative (often unprecedented and untested) strategies, and to accept new responsibilities.

Today, as global uncertainties continue to mount in intensity and in variety, cities are among the forefront flagbearers of a global future that has yet to be fully identified. Whatever the scenarios that can be imagined about the next wave of globalisation, cities will strive to be future-ready. The purpose of this section is to sketch out some of the avenues through which the paths chosen by cities will influence our collective future-readiness, at the national and global levels. It is now clear that in so doing they will also contribute to shaping our future.

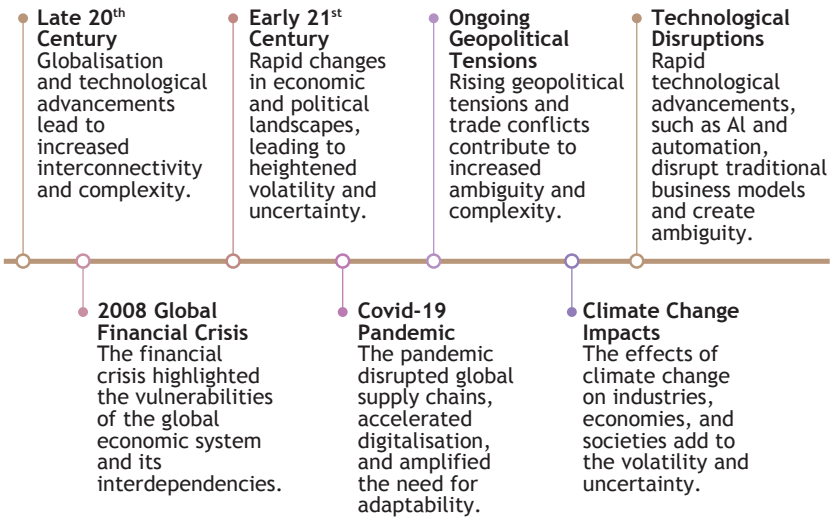
2 Cities will be key players in the post-global economy

In 2015, the World Bank studied some 750 cities around the world and made a staggering discovery: three quarters of them had grown faster than their national economies since the early 2000s (World Bank Group, 2015). At the turn of the century, globalisation was still the key game in town. That was before the financial crisis

[23] This trend is visible both in trade and in investment: nearshoring, friendshoring and other neologisms are hardly more than efforts to rebrand protectionism; these developments are now increasingly pervasive in a number of domains considered as 'strategic,' as well as touristic, cultural and education exchanges.

of 2008, the advent of Covid and the rapid deterioration in the international geopolitical climate, compounded by a worldwide retreat from multilateral cooperation and disciplines. The combination of such trends has nurtured the notion of a *VUCA Global Economy* (for volatility, uncertainty, complexity and ambiguity; see Figure 1 below). Yet the prominence of cities has increased even further since then.

Figure 1. The growth of VUCA in the global economy



Source: Author

Today's economy can be defined as 'post-global' in the same way that the economy of most of the 20th century could be qualified as 'post-steam engine:' when a disruptive innovation (whether technological, organisational, social or political) modifies our societies, its effects do not stop with the emergence of the next wave of change. If anything, subsequent innovations (in the case of the steam engine one may think of new energy sources and new ways of turning energy into motion) often contribute to amplify the effects of the initial impetus created. Globalisation is changing, but its fundamental principles (which include the

ability to harness the benefits of competition at a global level) remain a powerful engine to make the world a better place, i.e. more sustainable, less unequal and one in which values and purpose are a better guide for individual actions than greed and unquenchable thirst for power.

Over the last few decades, cities have proved more resilient than nation-states *vis-à-vis* external shocks. They have also displayed better abilities to innovate and adapt to the new conditions of global competition. It is the opinion of this author that this trend will accentuate in the future.

To illustrate the ways in which cities have outpaced nation states, I explore five key areas: health, climate change, investment, innovation and talent, showing for each case how cities have been able to build new competitive advantages and create innovative solutions.

2.1 Health – Lessons from SARS and Covid cast a long shadow

Recent case studies have shown how cities adopted innovative and bold strategies in the face of massive epidemics (Bris et al., 2022). When these crises were at their peak, most of them used a combination of three critical approaches combining digital tools, rapid policy measures and community engagement.

– **Digital technology:** Many cities adopted digital platforms and dedicated apps for contact tracing, disseminating information and telemedicine services to reduce the spread of the virus while maintaining essential health services. This approach was of course more effective in cities with good IT infrastructure and high rates of mobile phone penetration.

– **Municipal policy measures:** Implementing timely policies such as lockdowns and travel restrictions helped mitigate the pandemic's impact on human lives. Aligning available local resources to ensure the proper management of relevant protections (e.g. masks) and vaccination campaigns was also

a priority area in which many cities proved to be innovative, agile and efficient.

– **Community engagement:** Not all cities, however, had the ability or resources to deploy economic safety packages for local businesses and citizens. Support from the relevant nation states remained critical from that point of view. Engaging local communities in awareness campaigns and mutual aid networks fostered a collective response and ensured that vulnerable populations received support.

Once the public health situation had returned to more normal levels, many cities drew the lessons from their own experiences (as well as of those of other cities), in order to adopt longer term approaches, including in urban design and infrastructure development.[24]

– **Urban planning and design:** Reimagining urban spaces to promote social distancing, such as widening sidewalks, creating bike lanes networks and repurposing public areas, helped minimise transmission risks. Additional local initiatives to reconsider how certain buildings could be repurposed once teleworking became widespread also contributed to making cities more future-ready in the face of future health emergencies.

– **Public health infrastructure:** Strengthening public health systems with increased testing facilities, temporary hospitals and streamlined supply chains for medical equipment proved crucial during both the SARS and Covid epidemics. As shown by global surveys and measurements, in all parts of the world, a large proportion of urban citizens remains traumatised by their experience during those periods.[25]

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[24] From this point of view, a significant number of Asian cities (such as Singapore) benefited from a head start when Covid struck at the end of 2019, as lessons had been drawn from the SARS experience in 2002–2004.

[25] See for example the data collected for the production of IMD's *Smart City Index* since 2020 (https://www.imd.org/smart-city-observatory); more details are provided in the next part of this section.

These measures, among others, have shown how cities can adapt and respond effectively to public health crises, often faster and more efficiently than central governments (and even – in some instances – *in spite of* the inertia of such levels of decision-making).

2.2 Climate change – Long term and local are proving compatible

To a large extent, the diagnosis provided earlier about health emergencies also applies to actions related to climate change and sustainability: cities tend to act faster and more efficiently than nation states.

COP 28 (held in Dubai from 30 November to 12 December 2023) proved that large, complex multilateral conferences remain vitally useful, especially to tackle multifaceted issues with a long-term perspective. However, public opinions continue to consider that national governments often remain slow to undertake the actions that would conform with the commitments made at such global conferences. Cities, on the other hand, are places where tangible results are being achieved on a daily basis, with visible results.

Contrary to the traditional view that urban strategies are hampered by the frequency of local elections, an increasing number of cities have shown that short-term actions for greater sustainability can be compatible with longer-term strategies to enhance their ability to mitigate the effects of climate change.

Most of these efforts have focused on being both green and digital.

– **Multiplying green initiatives:** By improving building efficiency, investing in electric vehicles (and charging stations), optimising waste operations and investing in renewable energy and smart grids, cities are significantly reducing their greenhouse gas emissions.[26] Increasing the proportion of green spaces in the urban environment contributes not only to capturing more emissions, but also to improving the quality of life for citizens.

[26] Please see https://www.nlc.org/article/2022/04/22/the-top-5-ways-cities-are-addressing-climate-change/

In a number of cases, rehabilitating older industrial buildings has allowed to save on costs while highlighting the cultural and historical heritage of cities. Examples abound here, such as those of Bilbao (Spain), where the local river was 'unburied' after decades of being an industrial dumping site, or that of Shanghai, where the historical site of the Bund offers a striking visual contrast with that of the high-rise buildings of Pudong.

– **Leveraging digital opportunities:** Because urban populations often have a higher degree of familiarity with digital services (especially mobile phone apps), the rate of adoption of digital tools and mobile applications is also higher. This has allowed a growing number of cities to optimise traffic and parking, to encourage the use of public transportation, to offer public lighting where and when it is most needed, etc., functioning as powerful instruments to reduce the carbon footprint of cities, while enhancing the awareness of their citizens of the importance to change their consumption patterns.

2.3 Investment – FDI strategies have become more granular

Whether we take the approach of John Dunning or that of Michael Porter, foreign direct investment (FDI) theory points to the imminent, growing role of cities as investment attractors.

On one hand, **Dunning's eclectic theory** (Dunning, 1979) (or OLI, for ownership, location and internalisation factors) easily translates from its original framework (that of investments across national borders) to that of city-driven investment behaviours.

– Ownership advantage: There is no significant difference here between national and city levels. Investors can acquire or consolidate relevant competitive advantages (accessing a unique talent pool for example) with similar ease or difficulty in both cases.

– Location advantage: This is probably the area in which city-specific strategies (as opposed to nation-driven ones) offer the clearest advantages to global investors. By adopting a higher level of granularity, operators and owners of internationalised firms can identify the best places for production and distribution facilities (e.g. closer to local markets, or in the vicinity of

international transport hubs when inputs need to be imported or production reexported). This approach also allows the emergence of competitive bids from potential host cities, which will play in favour of investors.

– Internalisation advantage: Negotiating agreements and strategic alliances with local producers can be facilitated at the city level (e.g. when a municipality wants to develop its own brand as an investment hub, or in a particular sector). In such cases, the final decision of a particular investor to internalise or externalise a particular activity will not be significantly different from what it would be if dealing with a national government. However, the proximity of key local suppliers and partners will be a critical factor calling for city-level attention.

On the other hand, **Michael Porter's diamond model** (Porter, 1990)[27] is an even more direct fit for a local approach.[28] Its four key components – namely (1) firm strategy, structure and rivalry, (2) related supporting industries, (3) demand conditions, and (4) factor conditions – all gain in relevance and applicability once translated to the local (city or cluster) level.

This theoretical view is well supported by available data, as well as by the growing attention that global media and analysts are paying to cities as investment destinations. For example, the fDi Intelligence publishes an "annual list of the world's hottest cities and regions for foreign investment"[29] (Irwin-Hunt, 2024).

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[27] Also known as the Porter Diamond Theory of National Advantage.

[28] As amply demonstrated in Michael Porter's later work on clusters for example (Porter, 1998), as well as in applications of the diamond model to specific cities around the world. See for instance the conference paper of Elnably and Assem (2019).

[29] "Methodology note: The study of the 100 fastest-growing subnational locations for greenfield FDI in 2023 includes global top 10 lists for both cities and regions, as well as the top seven cities and top three regions in eight macro-geographies the world over. These lists were based on weighted scores for fDi Markets data. The most weight was assigned to annual growth in FDI project numbers between 2022 and 2023, followed by the growth rate of announced capex and expected jobs created by investments. The study also included retail FDI projects" (Irwin-Hunt, 2024, para.4).

For 2021/22, the top ranking cities in terms of FDI attraction were the following (Duffy, 2021).

Table 1. Top 25 investment destinations in 2021/22

Rank	City	Country
1	Singapore	Singapore
2	London	UK
3	Dubai	UAE
4	Amsterdam	Netherlands
5	Dublin	Ireland
6	Hong Kong	Hong Kong (China)
7	New York	USA
8	Shanghai	China
9	Paris	France
10	Tokyo	Japan
11	Beijing	China
12	Abu Dhabi	UAE
13	Bangalore	India
14	Munich	Germany
15	Wroclaw	Poland
16	Zurich	Switzerland
17	Toronto	Canada
18	Seoul	South Korea
19	Houston	USA
20	Warsaw	Poland
21	Chicago	USA
22	Moscow	Russia
23	San Francisco	USA
24	Vilnius	Lithuania
25	Montreal	Canada

Source: Author's compilation based on Duffy (2021)

At the time when this list was published, Duffy (2021) underlined that:

> amid what has been a particularly challenging period for the global economy and foreign direct investment (FDI) as a whole,

> Singapore has held onto its top spot in the Global Cities of the Future ranking for the fourth time in a row. London has also retained second place and Dubai has come in third. It has been a tumultuous year for FDI flows, with Singapore seeing much slower growth in inward FDI compared to London and Dubai, but still retaining its excellence across the board (para.1).

This assessment matches the conclusions of other analyses such as those of IMD's *Smart City Index* (described in more detail below). For the time being, it is important to note that (1) Budapest does not figure on that list; and (2) Singapore ranks 1st; while (3) Shanghai ranks 8th.

2.4 Innovation – A renewed awareness of the local nature of ecosystems

Created in 2007 at INSEAD, the *Global Innovation Index* (GII) has rapidly become the most respected global reference in the area of innovation performance.

Entitled *The Local Dynamics of Innovation*, the 2013 edition of the GII report (Dutta et al., 2013) called attention to the importance of local ecosystems as a key ingredient in national innovation strategies. At the time, the report's co-editors underlined that:

> the GII 2013 sheds light on the factors leading to the excellence of innovation hubs, such as the role of local 'champions' (large corporations), the availability of funding for the development of start-ups, and the importance of path dependency. Linkages among stakeholders (governments, firms, academia, and society) in the development of innovation capabilities – such as the existence of incubators and technology transfer programmes and the interaction of innovation clusters with local, inter-regional and global networks, and value chains – are included in the analyses (Dutta et al., 2013, p. v).

In 2020, the GII report started to include a section on science and technology (S&T) clusters,[30] which is now attracting the attention of city leaders, investors and innovators worldwide.

Table 2. Top-ranking clusters/cities in the 2023 edition of the GII report

Rank	Cluster	Economy
1	Tokyo-Yokohama	Japan
2	Shenzhen-Hong Kong-Guangzhou	Hong Kong, China
3	Seoul	Republic of Korea
4	Beijing	China
5	Shanghai-Suzhou	China
6	San Jose-San Francisco, CA	United States
7	Osaka-Kobe-Kyoto	Japan
8	Boston-Cambridge, MA	United States
9	San Diego, CA	United States
10	New York City, NY	United States
33	Singapore	Singapore/Malaysia

Note: Cities used as examples (Shanghai and Singapore) are highlighted. Shanghai is 5th, and Singapore is 33rd. Budapest is not in part of GII's top 100 innovation clusters.
Source: Author's compilation based on World Intellectual Property Organization data [Global Innovation Index 2023]

2.5 Talents – Cities are the real talent magnets

Regarding work practices and international talent flows, Covid contributed to accelerating some of the trends that were already clear at the turn of the century. On the employers' side, the

[30] The Science and Technology (S&T) Cluster ranking of the *Global Innovation Index* (more information available at https://www.wipo.int/global_innovation_index/en/) identifies local concentrations of world-leading science and technology activity. S&T clusters are established through the analysis of patent-filing activity and scientific article publication, documenting the geographical areas around the world with the highest density of inventors and scientific authors. World Intellectual Property Organization (WIPO) locates and ranks science and technology clusters through a geocoding method, mapping addresses and names pulled from documents to 96% accuracy. For additional methodological details and references, see the dedicated part of the GII website at https://www.wipo.int/global_innovation_index/en/2023/science-technology-clusters.html

growing ubiquity of information networks (especially when they are of broadband quality) has allowed organisations to routinely rely on remote talents and virtual teams as a 'new normal.' On the supply side of the labour equation, an increasing proportion of high-value talents have been able to work from practically any location with appropriate connectivity.

This phenomenon, however, does not cancel out the more traditional approach by which firms with an interest in foreign and global markets are attracted to locations where they can find vibrant ecosystems and opportunities to develop their markets as well as their innovation capabilities.

Both of these approaches give additional prominence to cities in the global talent equation. On the one hand, increased reliance on virtual teams, and the ability of high-value talents to work from any place with good connectivity have spurred talent attraction in places with high levels of quality of life, and high levels of services such as health, education or safety. On the other hand, global investors have tended to consider possible destinations with a much higher degree of granularity, which has benefitted cities (as opposed to nations).

As a result, some cities have become major talent magnets. This is one of the main reasons why global talent-related indices such as GTCI *(Global Talent Competitiveness Index)* started to include a specific section on cities as early as 2015 (Lanvin et al., 2016).

Through its dedicated *Global City Talent Competitiveness Index* (GCTCI), GTCI has repeatedly described and measured how cities have been able to deploy original and effective talent strategies. Analyses of GCTCI data also showed how much global talent competition was influenced by the emergence of new *talent hub cities* across the world. One of the findings of GCTCI was that second-tier cities (typically with populations of 100,000 to 1,000,000) have increasingly became the places where the most successful talent policies were deployed. Such cities frequently demonstrated an ability to be more dynamic and more attractive than larger metropolises.

Altogether, available data show that cities compete to attract talent through a variety of strategies, focusing on creating an environment that is conducive to personal and professional growth. In such a context, the following emerge as key priority areas for action:

– **Quality of life**: Talent-attractive cities offer a high standard of living, including safety, cleanliness, housing and amenities, which are all important factors to attract high-value internationally mobile talents.[31]

– **Innovative ecosystems**: Establishing vibrant innovation ecosystems by aligning the needs of young, educated workers with those of businesses and investors is important for startups and young entrepreneurs, but also for larger and more mature organisations which can benefit from synergies with local small, medium, and micro enterprises (SMMEs).[32]

– **Global connectivity**: The availability of high-speed broadband is critical to allow cities to benefit from new post-Covid ways of working. The presence of transportation hubs (e.g. international airports, railway or highway nodes) also remains a critical element to foster cities' growth and allow them to attract businesses as well as talents.[33]

– **Cultural and social opportunities**: Access to cultural, culinary, sports and leisure experiences is also a valuable asset to attract foreign talents and keep local ones.[34]

– **Education and skills development opportunities**: The local presence of a major university is often synonymous with multi-

[31] Please see https://news.outsourceaccelerator.com/cities-compete-retain-talent/

[32] Please see https://globalaffairs.org/sites/default/files/2021-01/report_cities-competing-for-talent-in-the-global-economy_20190401.pdf

[33] Please see https://globalaffairs.org/sites/default/files/2021-01/report_cities-competing-for-talent-in-the-global-economy_20190401.pdf

[34] Please see https://globalaffairs.org/sites/default/files/2021-01/report_cities-competing-for-talent-in-the-global-economy_20190401.pdf

disciplinarity and high-quality research centres. In addition to being a source of local talents, such facilities increase networking opportunities, as well as learning, upskilling and lifelong learning possibilities for the talents already employed in the city/cluster.[35]

– **Business-friendly environment**: Creating a business-friendly tax and regulatory environment to encourage startups and cutting-edge businesses can also provide specific cities with a comparative advantage to attract both employers and talents.[36]

Table 3. Top rankings for cities (talent magnets) in the 2022 edition of GTCI

Rank	City	Overall score
1	San Francisco (United States)	76.2
2	Boston (United States)	73.1
3	Zurich (Switzerland)	70.7
4	Seattle (United States)	69.2
5	Lausanne (Switzerland)	67.6
6	Singapore (Singapore)	67.2
7	Geneva (Switzerland)	65.4
8	Helsinki (Finland)	65.0
9	Munich (Germany)	64.5
10	Dublin (Ireland)	64.1
81	Budapest (Hungary)	45.7
83	Shanghai (China)	44.7

Note: Singapore ranks 6th, whereas the other two cities used as examples (Budapest and Shanghai) are highlighted. Their ranks are remarkably similar (81st and 83rd, respectively).

Source: Author' compilation based on INSTEAD, Human Capital Leadership Institute & Descartes Institute data [Global Talent Competitiveness Index 2023]

In the following, we shall see how successful cities stand out by combining two or more of those dimensions.

[35] Please see https://news.outsourceaccelerator.com/cities-compete-retain-talent/

[36] Please see https://news.outsourceaccelerator.com/cities-compete-retain-talent/

3 By showing the way to future-readiness, cities are ushering in the future itself

In the post-global economy described in the previous section, several additional elements will strengthen the roles of cities. They include the ability to face higher levels of uncertainty and to adapt their strategies as their environment will require. It is largely because they will strive to be future-ready that cities will increase our collective ability to shape the future, and align it to the values and principles our societies believe in.

To achieve this, cities will need to be more than "flourishing urban centres that successfully facilitate firm and industry growth to create jobs, raise productivity and increase incomes," as the World Bank underlined in 2015 (para 2). They will also have to be places where innovative approaches can be fostered to make our planet more sustainable, more inclusive and less unequal.

Recent global studies and rankings (such as IMD's *Smart City Index*) indicate that the most competitive cities are not necessarily major economic centres, capital cities or megalopolises. More and more, the most dynamic and successful urban environments can be found among second tier cities, where the concept of 'smart' is being redefined and implemented, often as a synonymous for 'future-ready.'

3.1 Smart cities, competitive cities and future-ready cities – A rejoinder

Up until the shocks of the early 21st century, starting with the SARS outbreak in 2002–2004 followed by the financial crisis of 2008–2009 and then by the Covid pandemic in 2020–2023, the competitiveness of cities was largely defined along the axes used for assessing the competitiveness of nations, namely: geographical and historical advantages, local economic advantages, and specific policies (e.g. fiscal) used as differentiators.

In today's uncertain environment, it is becoming clear that future-ready cities will be the ones able to combine strategic approaches

(as opposed to silos) relevant to a number of critical areas: climate change/sustainability, inequalities/inclusion and resilience to possible external shocks (e.g. health-related, or resulting from economic disruptions in trade, investment or access to strategic resources). This involves a holistic shift in urban systems, including transportation, housing and infrastructure, which tends to be more manageable in medium-sized cities than in larger ones.[37]

3.2 Future-ready cities are emerging as a harbinger of post-globalisation

In order to face today's uncertainties, cities of all sizes and all types are adopting innovative approaches, and sometimes new types of governance. As far as we can see, larger cities continue to enjoy strong comparative advantages as magnets for investment, talent and trade flows. However, inter-city competition has broadened significantly during the last few decades and now includes a significant number of second-tier cities. As the power and room for manoeuvre of nation states continues to erode, the complex mesh of cities is becoming a sizeable force in shaping the next wave of globalisation.

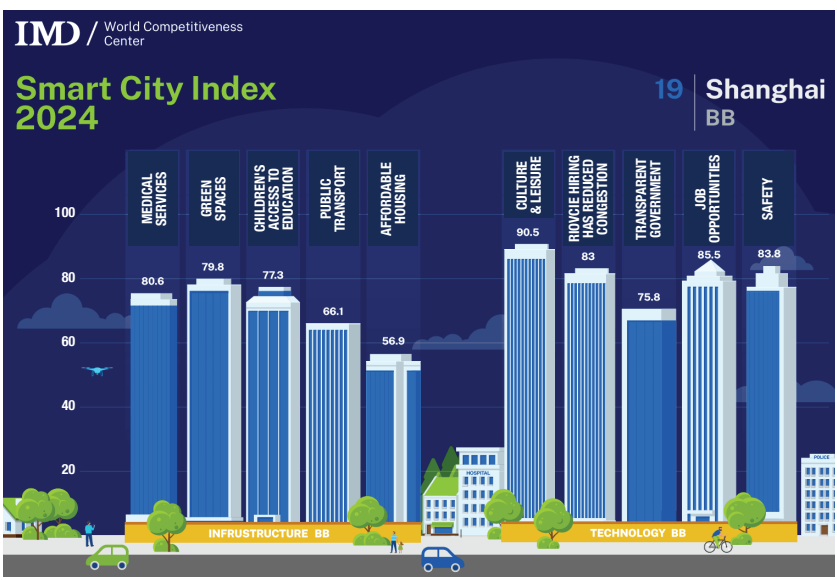
As cities continue to enhance their future-readiness, they will continue to benefit from the experience acquired in the five areas highlighted above (health, climate change, investment, innovation and talents). These are areas in which cities will continue to explore and open new avenues in domains as diverse as urban design, information infrastructure, transportation, architecture, energy consumption and waste management, but also governance, inclusion and diversity. Moreover, cities will pursue their efforts to combine such approaches. For example, an increasing number of those that have proven successful at attracting foreign investment are becoming 'selective hosts,' for instance by accepting only carbon-neutral investments.

[37] Please see https://www.weforum.org/agenda/2023/07/cities-transforming-systems-climate-change-adaptation/

The coming years will see a multiplication of city-based policies aiming to build global advantages through specific strategies and policies, but also through branding efforts. International alliances among cities will accelerate this movement by offering cumulative opportunities for cross-fertilisation and mutual learning. All of these elements combined will lead cities from all parts of the world to become first-line shapers of the future.

As shown by the three examples chosen to illustrate some of the above points (Budapest, Shanghai, Singapore), daunting challenges remain on the way to a post-global, urban-driven economy. Large metropolises in particular must face growing challenges in areas such traffic congestion, air pollution, waste management and energy consumption, but also safety, inequalities and space utilisation. Smaller cities are not immune to the same challenges. The following figures rely on the latest *Smart City Index* (SCI) data (IMD, 2024). They offer additional information on the respective situations of these three cities.

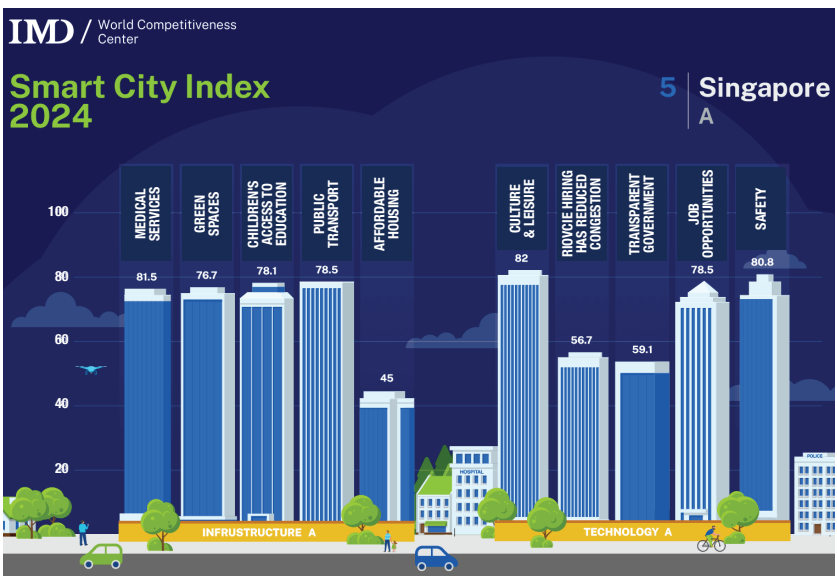
Figure 2. Shanghai



Source: IMD (2024)

Shanghai is the perfect example of a megalopolis where the massive challenges triggered by rapid demographic growth have generated wide-ranging responses and innovative solutions. With a population of about 30,000,000 (40,000,000 for the broader urban area), the city has been able to increase the volume of its main thoroughfares (in particular by digging new tunnels under the Hangpu River), while protecting the unique cachet of its historical areas (such as the Bund). During the recent period, the performance of the city has significantly improved in domains such as cultural activities and economic opportunities.

Figure 3. Singapore

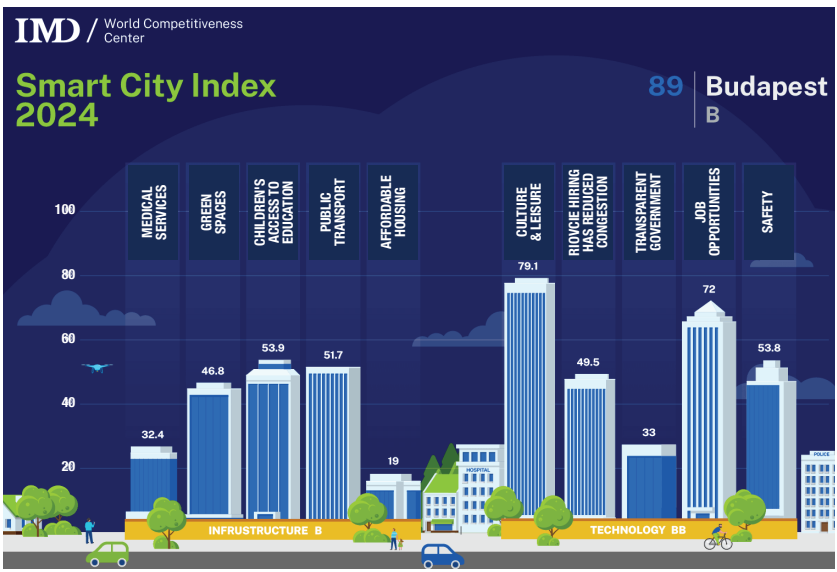


Source: IMD (2024)

Singapore (the city state) is very unique in many respects. Since becoming independent in 1965, this territory of 720 square kilometres and about 7,000,000 people has been ranking at the top of many global indicators (talent, competitiveness, education, innovation) both as a nation and as a city.

In its latest edition (2024), the IMD *Smart City Index* (SCI) shows that the city of Singapore is not only a place where high technology has become a part of the life of citizens, but also a city for which human-centricity and the facilitation of residents' and businesses' lives are constant concerns. Priorities pursued by local authorities include sustainability and preparedness for possible future challenges (e.g. health or weather-related). Available data show that areas in which citizens expect progress in the future include the cost of housing (World Bank Group, 2015).

Figure 4. Budapest



Source: IMD (2024)

Although it cannot compare to either Shanghai or Singapore in terms of size or international visibility, the city of Budapest is an interesting example, as it is a city in which a strong cultural and historical identity (present both in city design and architecture) has proven a powerful pillar to develop innovative and future-oriented solutions. Current concerns of citizens are still very much linked to access to health services, safety and the cost of housing. Innovative districts have been developed in various parts of the

city,[38] where relationships between high-quality universities and dynamic businesses (both Hungarian and foreign) have deepened. The city is also building its future-readiness by strengthening its branding as a Eurasian hub.

4 Conclusion – Key message and strategic priorities

By redefining their own way to be future-ready, cities will largely shape our collective future. Whatever their respective size, history, culture and specific competitive advantages, all kinds of cities will be contributing to what will be a fundamental trait of the next wave of globalisation: less centralised, more people-centric and agile enough to seize the opportunities offered by technological change while maximising its positive impact on protecting the environment, reducing inequalities and making our societies more peaceful and knowledge-based.

To do so – and hence be future-ready – cities will have core (and sometime leading) responsibilities to do the following:

– **Be aware of what technology can bring to addressing long-standing problems in novel ways**. Drawing lessons from past failures and successes will be an important component of that approach. Experimenting with new solutions should also be part of it.

– **Be human-centric**. Technology (including artificial intelligence, for example) will only solve a part of the problems at hand. In identifying the main issues to be addressed from the point of

[38] Budapest is host to the EIT Community Hub (European Institute of Innovation and Technology) (more information available at https://eit.europa.eu/news-events/news/new-eit-community-hub-budapest-support-more-innovators-across-central-and-eastern) and to Budapest Global (more information available at https://budapestglobal.org/en/mainpage), for example.

view of citizens, cities will be the places where the most relevant models can be tested and adopted regarding governance, urban design, economic and social choices, competitive strategies and branding.

– **Be open to trade, investment, innovation and talent flows**. Inclusion, diversity and openness to new ideas and solutions will be a powerful component of cities' future-readiness. By developing international networks of cities able to exchange best practices, all types of cities will acquire additional possibilities to adapt them to their local reality and environment.

Finally, city leaders, investors and citizens should keep in mind that the future belongs to younger generations (Lanvin & Sultan, 2022). Engaging with youth to allow cities to shape the future that we want will require that they have an appetite for tomorrow, rather than fears. It is the responsibility of those who are at the helm today to show – through their vision, their actions and their behaviour – that they believe that a better world is feasible. Cities are a good place to start.

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The Strengths and Challenges of South Korean Competitiveness

Taehyoung Cho – Daeyup Lee

This paper probes into the specific strengths of Korea's competitiveness and the challenges ahead. We examine Korea's competitiveness in terms of its resilience and dynamism in overcoming challenges, its investment in education and its highly educated workforce, its accumulated capital and strong manufacturing base, its rapid transition through the digital transformation, its openness and cooperative foreign relations, and the realisation of Korea's soft power potential, including pop music, movies and TV dramas.

We also delve into the burgeoning challenges: responding to the rapid demographic change and population decline, reducing 'dualism' in the economy, capitalising on artificial intelligence (AI) innovations and on the green transition as opportunities, responding to changes in the global economic environment and creating an environment that encourages entrepreneurship.

Finally, we conclude that Korea must endeavour to stabilise its macroeconomy amid rising uncertainty. Because it is the basis for stable growth, Korea must mitigate uncertainty, support mid- to long-term decision-making, strengthen its resilience during times of crisis and restore trust.

Journal of Economic Literature (JEL) codes: O1, O4, O5

Keywords: economic competitiveness, economic development, South Korea

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1 Introduction

Since the Second World War, there have been very few examples of countries that have progressed from being among the poorest to having a per capita GDP in excess of USD 30,000 in 2023. If the scope is limited to countries with a current population of more than 20 million people, only two regions – South Korea (hereafter referred to as "Korea" unless otherwise noted) and Taiwan – fit this description. Korea, in particular, began its economic growth amid the devastation of Japanese colonisation (1910–1945) and the Korean War (1950–1953), relying heavily on international aid, but by 2010, nearly 60 years later, it had joined the Organisation for Economic Co-operation and Development's (OECD's) Development Assistance Committee (DAC) and had achieved the economic milestone of transforming itself from an aid recipient to an aid donor. In 2021, the international community unanimously changed Korea's status from a "developing" to a "developed" country at the United Nations Conference on Trade and Development. Today, Korea's economic development model is recognised by many developing countries as a 'role model of hope,' showing them that they can also do well, as it is one of the few success stories that shows the process of rising from the bottom to the top.

Even looking at the recent situation, Korea appears to belong to a group of countries that have considerable competitiveness. For example, looking at the situation since 2020, Korea also recorded negative economic growth as the world suffered from the Covid-19 pandemic, but showed the fastest rebound among the G7 countries, together with the United States. At the same time, Korea is playing a leading role in various industries expected to become sources of future economic growth: the digital transformation, such as the spread of artificial intelligence; advancements in the semiconductor industry; the eco-friendly mobility revolution, including electric vehicles and batteries; cultural soft power

represented by pop music, movies and TV dramas; increasing geopolitical risks and the importance of security; responses to the climate crisis and innovations in energy technology; and addressing the challenges of a rapidly aging population.

Despite the positive assessments of the future economic situation, Korea currently faces various risks and new challenges. First, while Korea has achieved economic success, it is showing social distress, where excessive competition and social unrest have led to a loss of joy. The high youth unemployment rate, the highest suicide rate and the highest elderly poverty rate among OECD countries are just a few examples of the social pathologies caused by excessive competition in Korea. These indicators suggest that Korea needs to dramatically reorient its economic growth in terms of pace, goals and sustainability. Second, Korea is facing rapid demographic change, with the lowest-low birthrate and a super-aging society. If the recent trend of lowest-low fertility rates continues for any length of time, Korea's population will plummet, which could act as a powerful constraint on many industries. Now is the time for Korean society to collectively address this. Third, Korea's economic growth has been centred on a small number of large enterprises, which has led to a bifurcated corporate structure with a small number of internationally competitive, high-productivity enterprises on the one side, and a large number of low-productivity small and medium-sized enterprises (SMEs) on the other. The productivity gap between these two groups of firms has led to wage inequality between large and small firms and between full-time and part-time workers, and to a widespread "Golden Ticket Syndrome," where young people compete fiercely for good jobs in the professional, corporate and public sectors (OECD, 2022). Fourth, the processes of the digital transformation and the green transition will have a major impact on the survival and growth of global companies. Korean companies need to find ways to maintain their competitiveness in these areas through technological innovation. Fifth, uncertainties

around external conditions are increasing, including slowing globalisation, intensifying competition between the US and China, and rising geopolitical risks. For Korea, which relies on trade for a significant portion of its economy, the challenge is to seek ways to maintain foreign trade during these uncertainties, while proactively responding to the supply chain reorganisation due to cross-border competition.

In the following, we explore the specific strengths of Korea's competitiveness and the challenges that lie ahead. Section 2 examines Korea's competitiveness in terms of its resilience and dynamism in overcoming past challenges, its investment in education and its highly educated workforce, its accumulated capital stock and its strong manufacturing base, its rapid transition toward digital transformation, its openness and cooperative foreign relations, and the realisation of Korea's soft power potential. Section 3 examines the challenges in terms of responding to rapid demographic change and population decline, reducing the dualism in the economy, capitalising on AI innovation and the green transformation as opportunities, responding to changes in the global economic environment and creating a social environment that encourages entrepreneurship.

2 Strengths of Korean competitiveness

2.1 Resilience and dynamism in the face of challenges

Korea's strong competitiveness is largely attributable to the fact that, despite numerous internal and external challenges, it has maintained a long-term growth path, has moved beyond the middle income trap and has firmly established itself as a developed economy (Chart 1). Since the 1960s when economic development began in earnest, Korea has experienced several moments of negative growth. The Second Oil Shock (1979–1980),

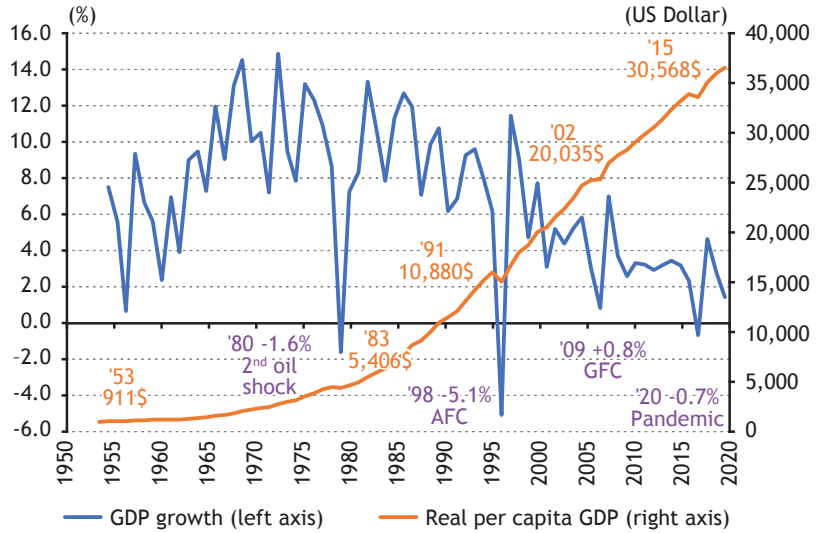
the Asian Financial Crisis (AFC) (1997–1998), the Global Financial Crisis (GFC) (2007–2008) and the recent Covid-19 pandemic (2020–2022) have been major challenges for the country. When crises hit, Koreans spontaneously united, collaborated and tried to come up with solutions to overcome them quickly. Examples of this include the 'gold-collecting campaign' to replenish foreign exchange shortages after the AFC, and the voluntary social distancing and active participation in vaccinations during Covid-19 pandemic.[39]

The evolution of real GDP in major advanced economies before and after the recent Covid-19 pandemic is shown in Chart 2. Comparing the seven countries that have both more than 50 million people and GDP per capita of more than USD 30,000, the USA and Korea experienced a temporary contraction in growth after the pandemic, but quickly recovered and returned to their previous growth paths. Italy, the UK, France, Japan and Germany, however, experienced a slower recovery after their economies faced severe negative growth due to the pandemic.

As such, it can be argued that Korea has not only shown resilience in the face of the economic crisis, but also has the potential to quickly overcome new types of crises in the future due to a number of factors discussed below. Another way to describe the potential for rapid recovery is Korea's *dynamism*. Dynamism is a trait that visitors often characterise as being Korean, a trait that is consistent with a 'culture of quickness,' or 'quickness.'

[39] The amount of gold collected through the gold drive exceeded 220 tons, and the drive is credited as being a key event that led to the early repayment of the country's subsequent IMF loan (Holmes, 2016). Korea is also credited with successfully weathering the Covid-19 pandemic thanks to good public healthcare facilities and high vaccination rates (Wang et al., 2023).

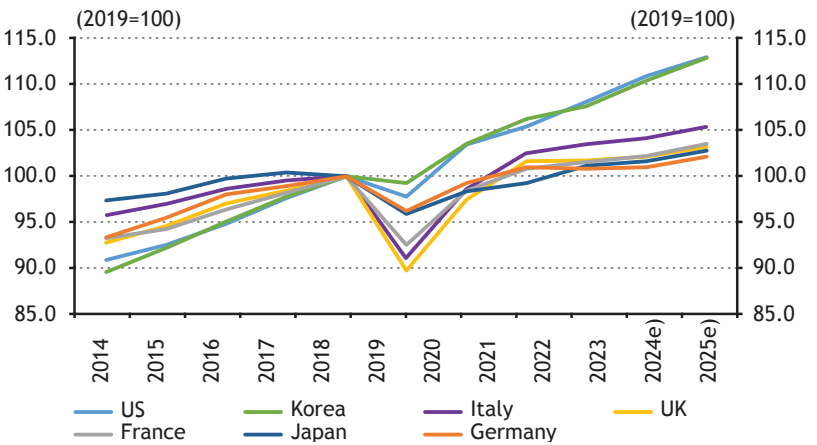
Chart 1. Economic growth in Korea



Note: Per capita GDP (in orange) is valued at 2020 prices.

Source: Authors' compilation based on Bank of Korea Economic Statistics System data (n.d.)[40]

Chart 2. GDP around the pandemic



Note: GDP growth forecast for 2024 and 2025.

Source: Authors' compilation based on OECD data [OECD Economic Outlook, Volume 2024 Issue 1]

[40] For more information, please visit https://ecos.bok.or.kr/#/

2.2 Investing heavily in education and retaining highly educated talent

Education is an issue that defines every sector of Korea.[41] Parents invest heavily in their children's education, and the government has invested heavily in securing talent through education. As shown in Table 1, the average number of years of education for the working-age population (15–64 years old) in Korea was 12.8 in 2015, which is in line with other major industrialised countries. In particular, the average years of education for the 25–34 age group, which represents the educational achievements of the past 30 years, was 14.2 years in 2015, higher than that in the US (13.8 years), reaching the highest level in the OECD.

This rapid improvement in educational attainment has provided the human capital for Korea's rapid transition from a traditional agricultural society to a society centred on light and heavy industry, and then since the 1990s to a society centred on the information and communication industry. In addition, while digital and AI innovations have become visible with the widespread adoption of the internet and mobile phones since the 2000s, Korea's high education level has enabled the country to quickly adapt to these changes and to create new industries. Furthermore, Korea has pursued an export-led growth strategy, which requires a large workforce with high levels of foreign language proficiency, and education has played a key role in this.

[41] In terms of the sources of philosophy in Korean society, the first word in Confucianism's classic text *The Analects* is the word "learning." In addition to this, in Protestantism, Roman Catholicism and Buddhism, reading and understanding the *Bible* and Buddhist scripture is a central recommendation.

Table 1. Comparison of educational attainment by age group (year)

	US	Germany	France	UK	Japan	Italy	Korea	Taiwan	China	India	Hungary
(15-64 age group)											
1950	8.7	7.2	4.4	6.5	6.9	4.4	4.6	3.2	1.8	1.0	7.2
1955	9.1	7.5	4.6	6.7	7.4	4.7	5.2	3.5	2.2	1.1	7.4
1975	11.7	7.2	6.0	8.4	8.8	6.5	7.5	6.1	4.8	2.1	8.8
1995	12.8	9.9	9.4	9.7	11.3	9.0	11.2	9.5	7.2	4.3	10.7
2015	13.3	12.3	10.3	12.9	12.8	11.0	12.8	12.4	8.7	7.4	12.0
(25-34 age group)											
1950	9.9	7.7	4.9	6.6	7.1	5.0	4.9	3.5	1.4	1.1	7.7
1955	10.3	7.7	5.0	6.9	8.0	5.2	5.6	3.9	2.6	1.1	8.0
1975	12.7	7.6	7.1	9.4	10.1	7.3	8.9	5.7	5.8	2.2	9.5
1995	13.2	10.9	10.3	10.3	12.8	10.5	12.7	11.3	8.2	4.5	11.4
2015	13.8	12.2	11.7	13.7	13.6	12.4	14.2	13.5	8.9	8.5	12.7

Source: Authors' compilation based on Educational Attainment Dataset, upgraded from Barro & Lee (2013)

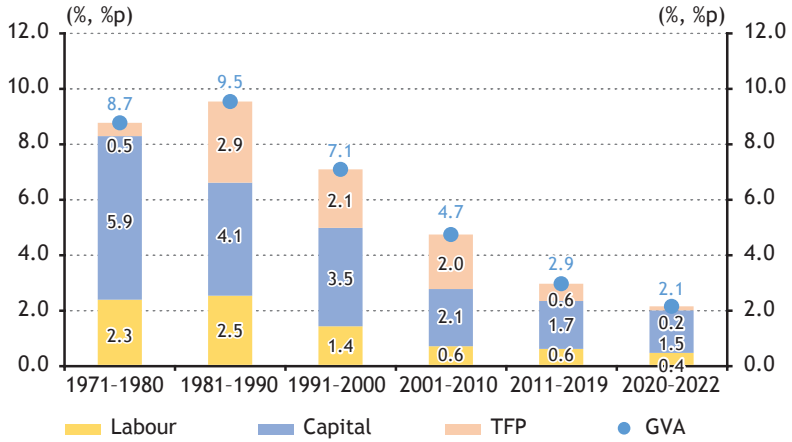
In addition, the high level of education among the population is also an important foundation for implementing new government policies. For example, Korea's food waste disposal is considered one of the best in the world (Yoon & Lee, 2023). However, the details of the system required a high intellectual level among the people. Of course, the voluntary cooperation of the people was also an important factor in the success of the system.

2.3 Accumulated capital over many years, strong manufacturing base

Korea's economic growth has been driven by large-scale capital accumulation. According to Cho (2023), from 1970 to 2022 the Korean economy grew at an annualised rate of 6.4%, with capital investment contributing 3.4%p, accounting for 53.1% of total growth (Chart 3). Korea spent 31% of GDP on fixed capital investment (1970–2022). This is significantly higher than the OECD average (23%) over the same period, lower than that in China (34%), and similar to that in Japan (30%). Of course, the accumulated capital was utilised properly because it was possible to acquire knowledge about related machinery and equipment and to secure operating skills through active investment in education.

Rapid capital accumulation contributed to Korea's industrialisation from an agricultural society to a manufacturing society and now to an information & communication society. Today, Korea has one of the highest manufacturing shares among industrialised countries, and it is at a high level relative to its income level (Chart 4). As a result, Korea has been ranked fourth or fifth in United Nations Industrial Development Organization's (UNIDO) global competitive industrial performance rankings since 2010. Samsung Electronics, SK, Hyundai Motor Company, LG Electronics, POSCO, Hanwha Group and HD Hyundai are some of the leading companies in their respective industries and have secured international competitiveness. Since the 2010s, internet platforms and messaging apps, such as Naver and Kakao, companies in the military sector, and companies related to secondary batteries for automobiles have all shown active growth.

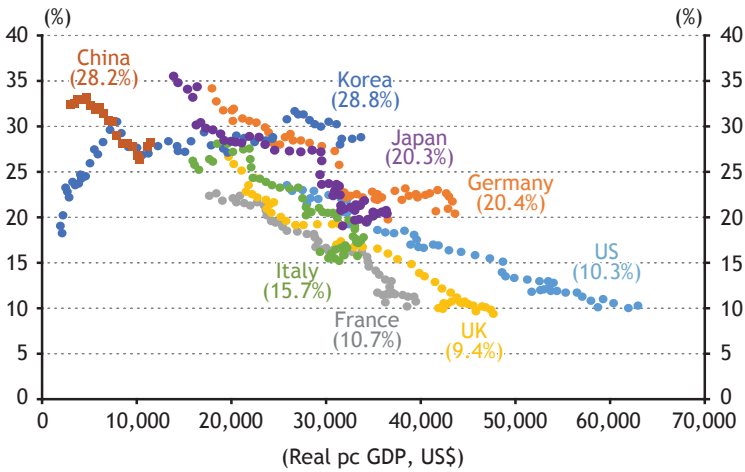
Chart 3. Decomposition of Korean economic growth



Note: Growth in gross value added (GVA) is decomposed into contribution by factor, for example, labour, capital, and total factor productivity.

Source: Authors' compilation based on Cho (2023)

Chart 4. Per capita GDP and share of manufacturing in GVA



Note: The share of manufacturing is computed as a portion of manufacturing value added in total GVA.

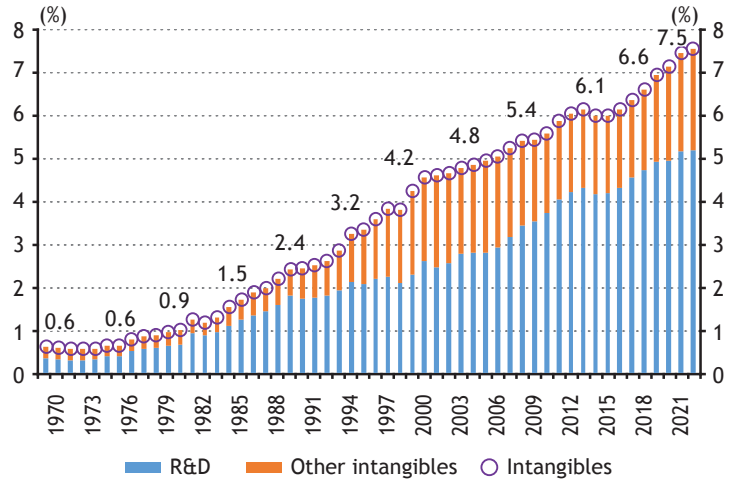
Source: Authors' compilation based on UN national accounts (2023)[42]

[42] For more information, please visit https://unstats.un.org/unsd/snaama/Downloads

Meanwhile, Korea has been investing not only in the quantitative accumulation of capital, but also in the qualitative accumulation of capital, meaning that it has invested not only in physical capital, such as construction assets and machinery, but also in increasing knowledge assets, such as R&D. In the case of R&D investment, which is known to be most closely linked to technological innovation at companies, investment exceeded 1% of GDP in 1985 and has been 4–5% since 2012 (Chart 5). As of 2022, Korea invested USD 87.2 billion, or 5.2% of GDP, into R&D, ranking sixth in terms of volume, after the US, China, Japan, Germany and the UK, and second only to Israel as a percentage of GDP (Chart 6). As a result of its aggressive R&D investment, Korea's industrial technology is 88.0% of the US's (0.9 years behind), the world leader, according to KEIT (Korea Planning & Evaluation Institute of Industrial Technology, 2024), lagging behind the EU's 93.7% (0.39 years behind) and Japan's 92.9% (0.43 years behind), but ahead of China's 83.0% (1.2 years behind).[43]

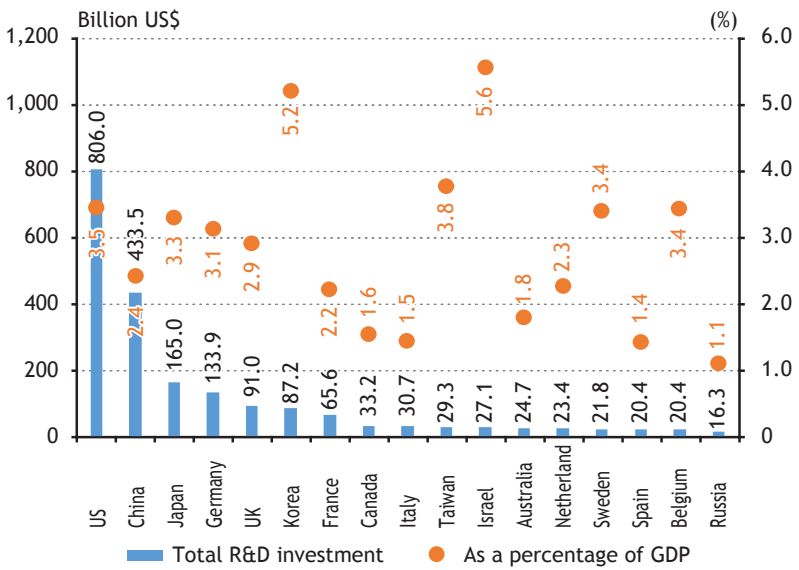
[43] The KEIT evaluates the technological level and the number of technological gap years behind for each country, as well as the importance, urgency and impact of each technological field, for Korea, the US, Japan, China and the EU. Technology is broadly divided into 25 industrial technological fields, which are further subdivided into 74 large technological fields and 281 medium-sized technological fields. In 2023, based on the 25 industrial technological fields, there were 17 that were considered best in their field from the US, four from Japan, three from Europe, and one from Korea.

Chart 5. R&D investment in Korea



Source: Authors' compilation based on Bank of Korea Economic Statistics System data (n.d.)[44]

Chart 6. Comparison of R&D investment



Source: Authors' compilation based on Korea Institute of Science & Technology Evaluation and Planning (2024)

[44] For more information, please visit https://ecos.bok.or.kr/#/

Table 2. Ranking in *Global Innovation Index*

	2013	2015	2017	2019	2020	2021	2022
Switzerland	1	1	1	1	1	1	1
United States	5	5	4	3	3	3	2
Sweden	2	3	2	2	2	2	3
United Kingdom	3	2	5	5	4	4	4
Netherlands	4	4	3	4	5	6	5
Korea	18	14	11	11	10	5	6
Singapore	8	7	7	8	8	8	7
Germany	15	12	9	9	9	10	8
Finland	6	6	8	6	7	7	9
Denmark	9	10	6	7	6	9	10
China	35	29	22	14	14	12	11
France	20	21	15	16	12	11	12
Japan	22	19	14	15	16	13	13

Source: Authors' compilation based on World Intellectual Property Organization (2023)

At the same time, Korea made significant progress in the World Intellectual Property Organization's (WIPO) *Global Innovation Index* during the pandemic. The country was generally ranked in the top 10 in the 2010s, but since 2021, it has jumped to the fifth or sixth position. This is in line with the recent significant increase in the number of patent applications filed from Korea. According to the number of patents filed with the United States Patent and Trademark Office (USPTO), Korea has seen steady growth since the 2000s, surpassing Germany, the UK and others, to rank fourth in the world as of 2020, behind the US, Japan and China (USPTO, n.d.).

As such, the human, physical and knowledge capital accumulated in the process of economic development are gradually synergising, transforming the Korean economy into a society that increasingly displays global competitiveness. In particular, it is believed that Korea will be able to respond flexibly and quickly to new

challenges through its robust manufacturing capabilities and the mixing and fusion of various industries.

2.4 Rapidly adapting to new changes, including advancements in digitalisation

Korea has developed a wide range of industries during its growth, but the development of the information and communication technology (ICT) industry has been a key factor in the country's economic transformation from a middle-income country to a developed country. This has made Korea one of the key players in the leading industries of the current global economy, namely semiconductors, mobile phones, displays, mobile telecommunication services, software development and internet-based information services. This has laid the foundation for the country to play an important role in the upcoming AI revolution.

According to the IMD, Korea is ranked sixth in the world in terms of overall global digital competitiveness as of 2023 (Table 3). It ranked first in future readiness, but 10th and 12th in knowledge and technology, respectively. If we look at countries with a population of 20 million or more, Korea ranked second behind the US. This indicates that Korea has a competitive position in digitalisation, which has been established through ICT and developed with the proliferation of business using computers, mobile phones and the internet.

Table 3. *IMD World Digital Competitiveness Rankings*

	2019	2020	2021	2022	2023
Overall	10	8	12	8	6
Knowledge	11	10	15	16	10
Technology	17	12	13	13	12
Future readiness	4	3	5	2	1

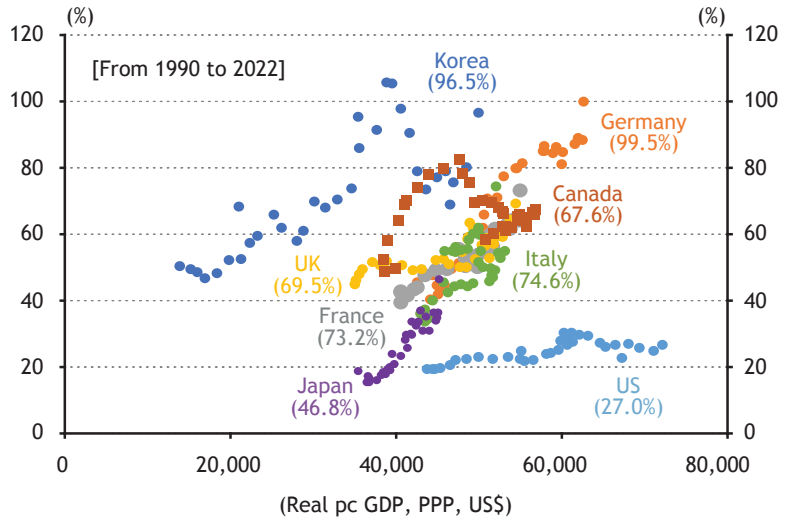
Source: Authors' compilation based on Bris & Cabolis (2019; 2020; 2021; 2022); Bris (2023)

2.5 High openness and cooperative foreign relations

Since the 1960s, Korea pursued an export-led growth strategy as its economic development strategy. The foreign exchange earned from exports has been a major source of financing to acquire capital goods and advanced technologies, as it enabled economies of scale in the face of scarce domestic resources and markets. Korea's high openness to the outside world makes it highly susceptible to rapid changes in the global environment, but openness also plays an important role in overcoming these changes wisely.

Chart 7 shows trade dependence, including both goods and services, and shows that, as of 2022, Korea's trade dependence is around 100%, similar to Germany's, which is significantly higher than that of major industrialised countries. In addition, Korea has signed 21 free trade agreements (FTAs) with 59 countries over the past 20 years, starting with the Korea-Chile FTA, and continues to pursue FTAs with major trading partners, covering both large and advanced economies. Chart 8 shows the ratio of overseas investment to GDP for major countries. Since the mid-2000s, Korea has significantly expanded its FDI (foreign direct investment), including the construction of overseas production bases, and is expected to spend more than 5% of its GDP on FDI as of 2022. While the scale of Korea's FDI is still low compared to other developed economies, it is expected to increase further in the future given the need to rebuild the global eco-friendly transition and the resource supply chain, as well as the country's shrinking population and labour shortage.

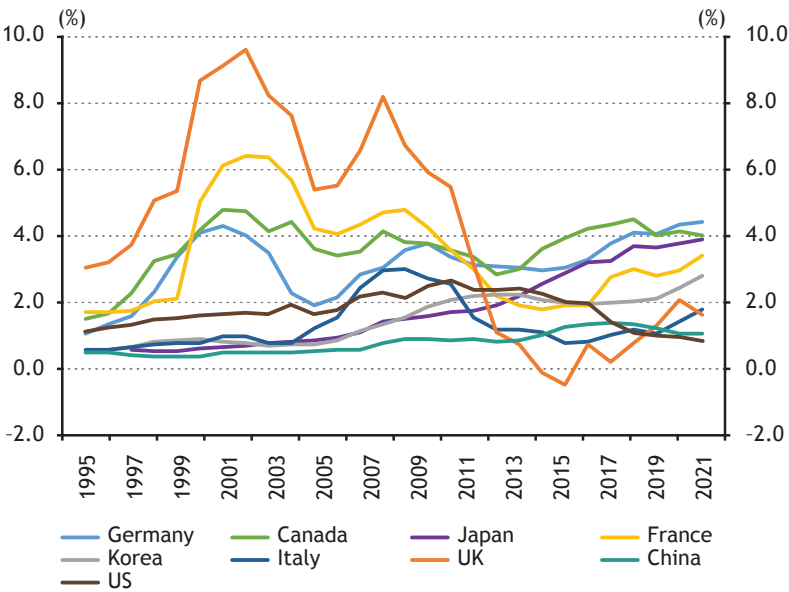
Chart 7. Trade openness as a % of GDP



Note: Trade includes both goods and services.

Source: Authors' compilation based on world development indicators (2024)

Chart 8. Direct outward investment as a % of GDP (5-year moving average)



Source: Authors' compilation based on IMF and UN data

Korea has maintained cooperative foreign relations with many countries around the world during its growth process, which has been the foundation of its export-led growth. In particular, Korea has a better understanding of the pains and needs of developing countries because it started as a low income country and has since reached the developed world in a short period of time, and so it can play a role as an intermediary between developed and developing countries. Also, from the perspective of developing countries, the fact that Korea does not have a history of invading other countries, the fact that Korean companies have been relatively committed to the projects they have undertaken overseas, and the fact that Korea has been trying to help developing countries grow on their own are all positive assets for the international community. Korea's values of co-prosperity, respect, sincerity, friendship, competence, and shared values have also been a source of confidence for partner countries.

2.6 Unleashing Korea's soft power potential through pop music, movies, TV dramas and other forms of art

Soft power, a concept coined by Joseph Nye of Harvard University, refers to the ability to win through attraction rather than coercion, such as money or power, as a means of persuasion (Nye, 2005). It is not the same as hard power, which coerces others through the threat of force, but rather induces others to pay voluntarily. Soft power is manifested as a favourable opinion of a country or a preference for its culture.

While Korea has long tended to admire and consume Western culture, since the 2000s Korean culture itself has become one of the more preferred cultures around the world. Korean music, movies, TV dramas and video games are all becoming increasingly popular, followed by preferences for Korean cuisine, makeup styles, fashion and more.

Korea has a long history of around five thousand years in view of Korean perception and extensive historical connections that span

the Korean Peninsula, Manchuria, Mongolia and elsewhere in Central and Northeast Asia. In addition, the coexistence of various religions, including Shamanism, Confucianism, Buddhism, Taoism, Roman Catholicism and Protestantism has created a rich cultural heritage. This suggests that the world's interest in Korean culture can go much deeper. As Korea's cultural influence grows, the world's favourable opinion toward Korea and toward Korean products will increase, and it is expected to play a significant positive role in the Korean economy.

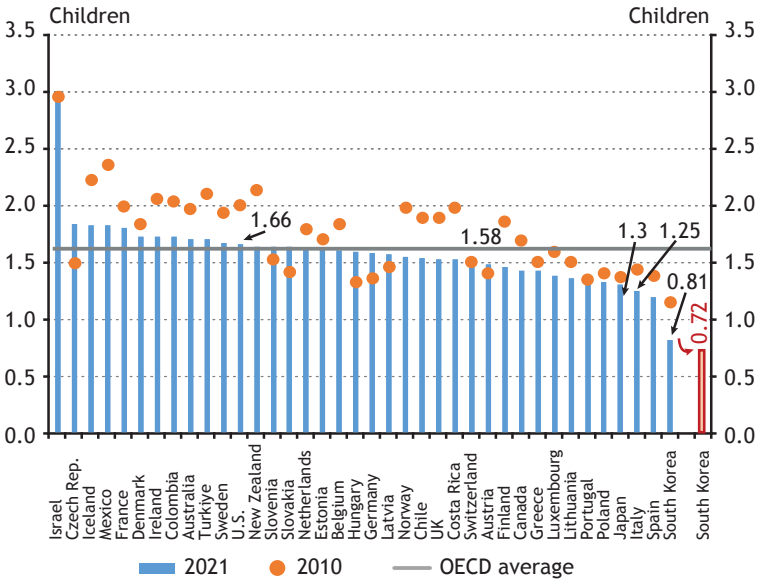
In addition, it should be noted that Korea has very strong 'spiritual power' in terms of Christianity. Protestantism has played an important role in transforming the old Korean society into a modern one, as well as Roman Catholicism, and in enlightening the Korean people in terms of democracy and equality under a common deity since at least the late 1800s. Korea currently sends out some of the most Protestant missionaries in the world.

3 Challenges for Korean competitiveness

3.1 Dealing with rapid demographic change and a population decline

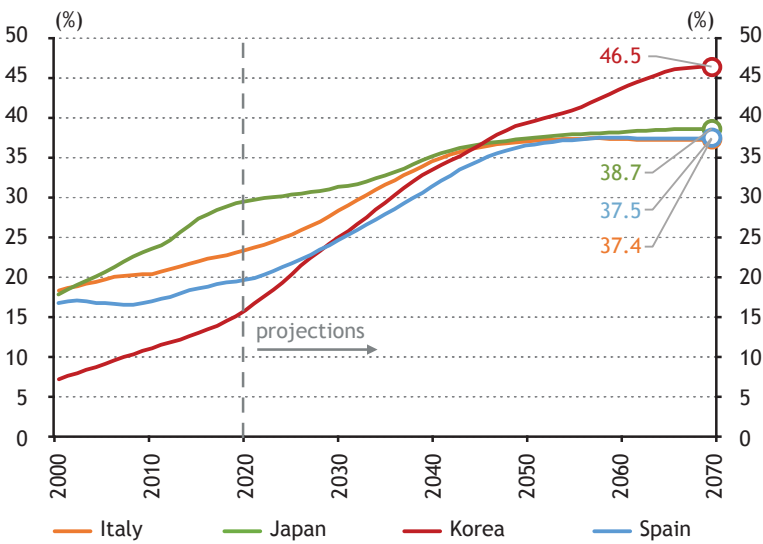
While the previous sections have discussed the competencies of the Korean economy, the following sections address various challenges that the economy currently faces. The most intractable of these challenges is a prolonged period of unprecedentedly low fertility in the country, which is resulting in a population decline, as well as a rapidly aging population (Hwang et al., 2023). Korea's total fertility rate, 0.81 in 2021, fell to 0.78 in 2022 and to 0.72 in 2023. In 2021, its total fertility rate was the lowest among OECD member countries (Chart 9) and the second lowest in the world among 217 countries for which the World Bank compiles statistics, after only Hong Kong (0.77 in 2021).

Chart 9. Total fertility rate among OECD countries



Source: Authors' compilation based on OECD data

Chart 10. Ratio of population over 65 among total population



Note: Korea is compared with three other super-aged societies.

Source: Authors' compilation based on UN (2022)

Korea's low fertility rate is unlikely to rebound in the short term, and the country's future demographic outlook is extremely bleak. According to demographic projections provided by Statistics Korea (2023), the country's population is expected to shrink from 51.67 million in 2022 to 36.22 million in 2072, which is close to the country's population in 1977 (Chart 9). A more optimistic projection predicts an expected population of 42.82 million in 2072, which is close to levels last seen in 1990, while a more pessimistic projection predicts an expected population of 30.17 million, which is close to 1967 levels. In addition, as the population is rapidly aging due to a low birthrate, Korea is facing the extremes of a super-low birthrate and a super-aged society (Hwang et al., 2023). The proportion of Korea's population aged 65 and older is expected to increase from 17.5% in 2022 to 20.3% in 2025, making it an official super-aged society. This is the quickest transformation from an aged society into a super-aged society among the OECD members countries that have already become super-aged (17 countries, as of 2021). It took Japan 10 years for that change and it took Italy 18 years. Only seven years have passed since Korea became an aged society in 2018. According to the United Nations Department of Economic and Social Affairs (2022), Korea is expected to have the highest proportion of elderly people among OECD countries by 2046, surpassing Japan, and the highest in the world by 2062.

Declining births and an aging population affect macroeconomic trends through a variety of paths. A recent empirical study of OECD member countries found that aging and declining populations are associated with lower growth, investment and real interest rates (Aksoy et al., 2019). Using regional data for the US, the study found that population aging reduced GDP per capita from 1980 to 2010. Two thirds of the total effect was driven by a slowdown in labour productivity growth and one third by a slowdown in employment growth (Maestas et al., 2023). In addition, low fertility and population aging are associated with a downward trend in the natural interest rate

(Laubach & Williams, 2003; Holston et al., 2023) and by increases in government debt (Yared, 2019), which constrain monetary and fiscal policies. Population aging and low fertility are each categorised as a factor that decreases the natural interest rate through an increase in savings and a decrease in borrowing, respectively.

In the case of Korea, analysis shows that, unless there is a dramatic rebound in the fertility rate or a significant improvement in productivity, the economy will enter a phase of negative economic growth in the 2040s due to a labour supply decline (Cho, 2023; Lee et al., 2024). The Korean government has also recognised the seriousness of its population decline, with several ministries jointly announcing measures to reverse the decline, as announced in June 2024. The future of the Korean economy depends on how these demographic issues unfold.

3.2 Alleviating economic dualism

Korea's economic growth strategy has included nurturing its industries around a small number of large conglomerates, known as *chaebol*. Over time, however, this has split the country's economy into two parts. The first part includes a small number of globally competitive conglomerates, and the second part is made up of a large number of small and medium-sized enterprises (SMEs) that either provide goods and services to those conglomerates or focus on the domestic market. As a result, the conglomerates have attained high productivity and considerable economic power, while the SMEs have had to rely on government support due to chronically low levels of productivity.

The role of large enterprises in Korea is generally smaller than in other OECD member countries. In Korea, only 1.3% of firms with 10 or more employees are considered "large firms," meaning they employ 250 or more people. The share of large firms among total

employment is also one of the lowest among OECD members, at 27.4%. In other words, in Korea, it is difficult for competent SMEs to grow into conglomerates without any help. Creating a field of competition in which startups can grow into large enterprises has become a major challenge for the Korean economy.

The country's economic dualism is manifested in the wage gap between conglomerates and smaller companies. While large companies, due to their high productivity, offer stable, high-paying jobs, many small and medium-sized enterprises with low productivity tend to provide low-paying, irregular jobs. Women, meanwhile, have often been forced to take career breaks after childbirth, which has further disadvantaged them in the labour market.

In the meantime, the country's youth have been fiercely competing for high-paying, full-time jobs at large corporations. As part of this process of competing for better jobs, young people have spent extended periods of time preparing for employment, leading to a decline in the youth employment rate. In addition to all this, the "Golden Ticket Syndrome" (OECD, 2022), which refers to Korean students' competition for desirable jobs in the professional, corporate and public sectors, has in turn resulted in competition to get into prestigious universities. In short, economic dualism has led students to consume excessive amounts of energy in their competition for prominent universities and jobs. As a result, various attempts to increase access to new fields of study or to encourage and make lifelong learning feasible as a response to labour market changes induced by industry upheaval have not been receiving sufficient attention.

Table 4. Role of large firms with 250 employees or more (%)

	Employment	Number of firms	Production
France	68.2	5.5	80.6
Sweden	65.8	7.1	77.3
Germany	64.8	6.0	79.8
OECD (*28 countries*)	46.9	4.9	63.2
Spain	44.1	3.3	62.1
Japan	37.9	3.9	55.5
Italy	35.0	2.1	48.3
Korea	27.4	1.3	53.3

Note: Figures indicate the ratio of firms with 250 or more employees to firms with 10 or more employees for each indicator.

Source: Authors' compilation based on OECD structural business statistics by size, class, and economic activity (ISIC Rev. 4)

3.3 Leveraging tech innovation and the green transition as opportunities

The world is currently facing two major changes: the technological revolution, known as the Fourth Industrial Revolution (Schwab, 2016), and the transition to a greener economy in response to climate change. The Fourth Industrial Revolution refers to the development of technologies including the Internet of Things (IoT), Big Data, cloud computing, robotics and 5G. Unifying all of these technologies is artificial intelligence (AI), a sort of universal or binding technology. AI is based on Big Data, algorithms and computing power. Cloud and 5G technologies accelerate AI's capabilities. Self-driving cars, 3D printing, virtual assistants and other similar forms of high tech are all the result of AI integration. Moreover, the usage of AI is expanding with the emergence of generative AI, and AI is thus likely to act as a force that will significantly change the entire social system, including politics, the economy, society and culture in general.

Korea's AI competitiveness is currently at meaningful levels. According to the UK's Toroise Media, Korea ranked sixth in terms

of AI competitiveness in 2023, behind the US, China, Singapore, the UK and Canada. Specifically, the country has especially shown strengths in the development sector. However, the current situation is far from optimal, since the gap between Korea and the leading countries in AI is quite large, and future development of AI is likely to be dominated by the monopolistic market power of such leading countries. While becoming a leading country in terms of AI technology may be improbable, it is still crucial for Korea to secure its competitive advantage in areas where it has strengths. Furthermore, advances in AI will inevitably rely on hardware that enables high-performance computing capabilities, which will create opportunities for Korean firms that have strengths in this area. In particular, it will be important to improve the performance of memory semiconductors and to make solid progress in developing system semiconductors, a field in which Korea has a relatively weak presence (Tortoise Media, 2023).

Table 5. *Global AI Index*, top 10 countries (2023)

Rank	Country	Overall	Talent	Infrastructure	Operating environment	Research	Development	Government strategy	Commercial
1	US	1 (100)	1	1	28	1	1	8	1
2	China	2 (61.5)	20	2	3	2	2	3	2
3	Singapore	3 (49.7)	4	3	22	3	5	16	4
4	UK	4 (41.8)	5	24	40	5	8	10	5
5	Canada	5 (40.3)	6	23	8	7	11	5	7
6	Korea	6 (40.3)	12	7	11	12	3	6	18
7	Israel	7 (40.0)	7	28	23	11	7	47	3
8	Germany	8 (39.2)	3	12	13	8	9	2	11
9	Switzerland	9 (37.7)	9	13	30	4	4	56	9
10	Finland	10 (34.9)	13	8	4	9	14	15	12

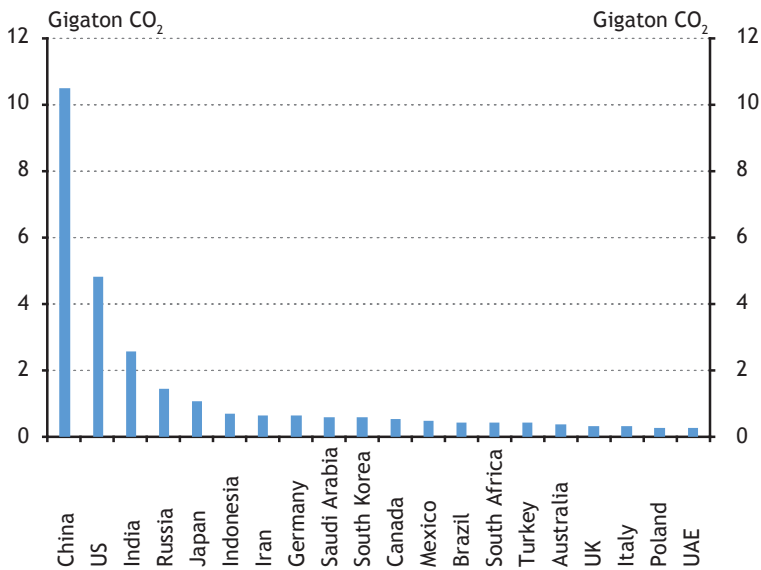
Note: Figures in parentheses indicate index numbers. There is big gap between the US and China on one hand, and then other countries.

Source: Authors' compilation based on Tortoise Media (2023)

Going green in response to the climate crisis is also an important task for the country. Korea is heavily dependent on manufacturing and on other industries that have high greenhouse gas emissions, such as steel, petrochemicals, oil refining, cement and coal power generation. As a result, as of 2022, Korea is the 10th largest emitter of carbon dioxide in the world (Chart 11).

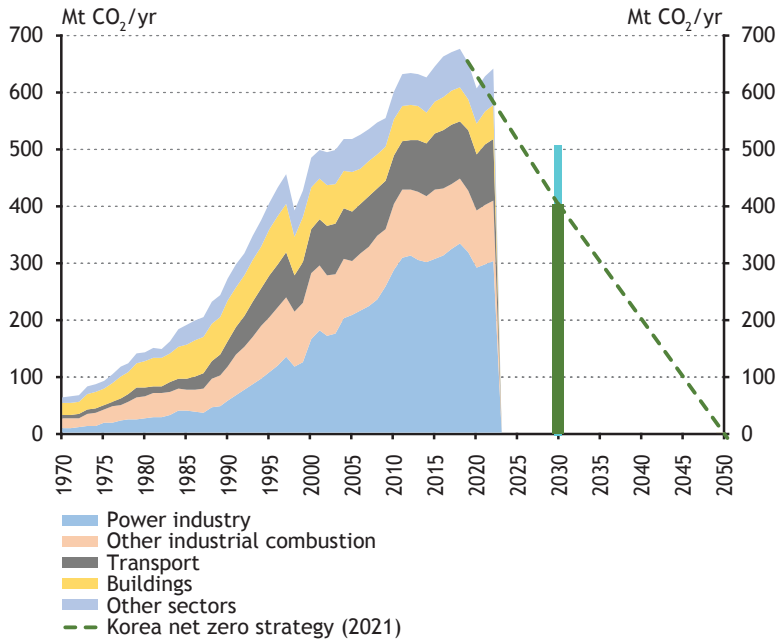
In compliance with the Paris Agreement, the Korean government announced in 2021 that it would reduce carbon dioxide emissions to 40% of 2018 levels by 2030 and achieve net-zero emissions by 2050 (Chart 12). In 2023, the government also announced adjusted targets across certain sectors, taking into account the feasibility of each mitigation measure. However, the international community's assessment of the country's carbon reduction efforts has not been favourable so far. According to UNFCCC COP28's Global Stocktake, the US and EU mitigation targets and policies have been assessed as being "insufficient" to meet the goals of the Paris Agreement, while those of China, India and Korea have all been deemed "highly insufficient."

Chart 11. CO_2 emissions from energy



Source: Energy Institute (2024)

Chart 12. Korea's net zero strategy



Source: Authors' compilation based on Crippa et al. (2022)

To combat climate change, Korea must reduce its dependence on fossil fuel energy, especially in terms of electricity generation. It must swiftly increase its use of solar and wind power. In addition, advancements in energy and environmental technologies are crucial to responding to climate change. Technologies must be developed in order to lower the cost of solar and wind power generation. Technological developments that boost the use of hydrogen reduction steelmaking in the steel sector, carbon capture, storage and utilisation technology in fossil fuel-intensive industries, the production of high-performance electric and hydrogen vehicles, breakthroughs in hydrogen-related technologies and the maximisation of energy efficiency in buildings must all be accelerated. Of course, encouraging

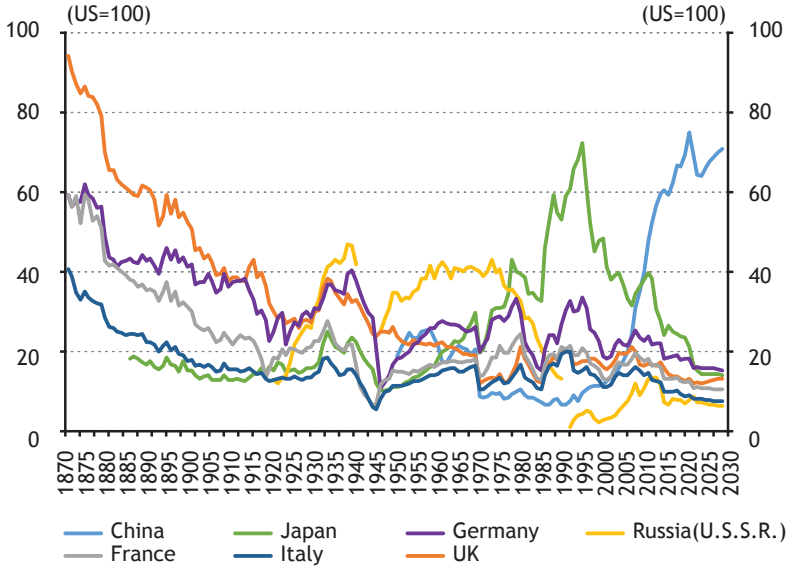
the country's population to conserve energy is also important. Supporting efforts to combat climate change through the financial sector is important as well. Reorganising systems and developing relevant financial instruments so that more resources can be used to respond to climate change will be necessary. In addition, financial measures must also be utilised to pressure economic agents both directly and indirectly.

3.4 Responding to changes in the global economy

As Korea has a very open economy, it tends to be highly dependent on changes in global conditions. Since the Global Financial Crisis (2007–2008), uncertainties in external conditions, such as the globalisation of world trade, intensified competition between the US and China, and geopolitical risks, have been increasing (Aiyar, 2023).[45] Moreover, as China's rapid economic growth has brought it closer to surpassing the US in terms of economic size (Chart 13), and as the perception that it is building its own world order, distinct from US values, continues to spread, US efforts to limit China's access to global supply chains in key industries (semiconductors, batteries, precious metals, pharmaceuticals and others) are increasing.

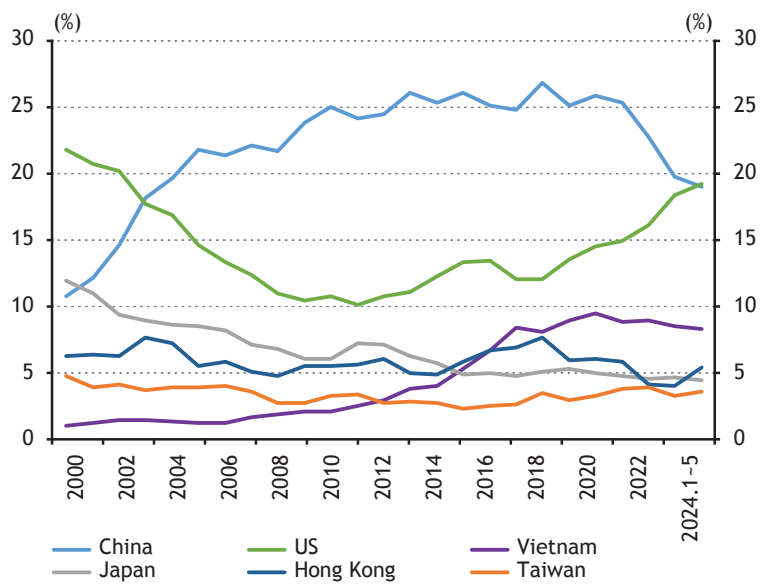
[45] The slowdown in world trade growth in the 2010s can be attributed to the prolonged effects of the financial crisis, which led to contractions in domestic demand, including consumption and investment, in advanced economies, to intensified competition between the US and China (Grossman et al., 2024), and to China's and India's emphasis on domestic markets (Goldberg & Reed, 2023).

Chart 13. Relative size of GDP to US (=100)



Source: Maddison (2003), UN, IMF

Chart 14. Share of Korea's exports, by country



Source: WTO

Meanwhile, both the US and China are Korea's most important export markets (Chart 14). It would be impossible to completely separate either country from Korean exports. However, the US's de-risking strategies cannot be ignored. Accordingly, Korea needs to maintain friendly relations with China while at the same time taking US strategies toward China into account. In particular, joint efforts to address climate issues are essential. In addition, the country must respond to the reorganisation of supply chains for raw materials and production bases. If issues along the global supply chain arise, Korea needs to establish alternative supply chains outside of China, even for items that have been mostly imported from China in the past. In short, a 'China Plus One' strategy would be one possible option. Building partnerships in terms of development and resources with resource-rich countries around the world will also be necessary to prepare for the possibility of prolonged supply chain disruptions. This will help minimise any negative impact on the Korean economy even if external risks increase due to conflict between the US and China.

3.5 Creating an encouraging environment for young people to start innovative businesses

While Korea has been investing heavily in R&D, the country has not seen much growth in corporate productivity since the 2010s. Declines in productivity have been a universal phenomenon across industrialised countries after the Global Financial Crisis (Goldin et al., 2024). However, improving productivity is an indispensable prerequisite for the Korean economy to move forward.

According to a recent study (Lee et al., 2024), the country needs to accomplish three tasks to encourage firms' innovative activities that are directly and indirectly linked to productivity. First, more capital should be allocated to basic research in R&D. Second, venture capital markets should be vitalised to ensure efficient financing for innovative companies. Third, appropriate social conditions for nurturing ambitious youth as they become

innovative entrepreneurs should be created. This third task, in particular, which aims for the creation of firms appropriate to the new era, must be actively promoted, as that could awaken drive and vigour and restore confidence among youth who are prone to becoming risk-averse, together with making improvements in the country's income level.

Developing innovative start-ups, however, goes hand in hand with the overall reorganisation of social processes. Fostering a creative and digitalised educational environment, allowing diversity among educational programmes, overcoming the dominance of private education, rationalising the university entrance system, changing the social structure to create a pluralistic system of opportunities, making lifelong education the norm, creating flexibility in the labour market, cultivating a culture tolerant toward bankruptcy and fostering venture capitalists with a good eye for innovative entrepreneurs are all important challenges.

4 Conclusion

Over the past 70 years, the Korean economy has seen miraculous growth from a low-income country to a middle-income country, and has now obtained many opportunities in our digitised world to secure its position as a developed country. Resilience and dynamism in overcoming challenges, a highly educated workforce, accumulated capital and a robust manufacturing sector, success in the digital transformation, openness and cooperative foreign relations, and soft power potential have all played a crucial role in this process.

The world is now less safe than before and is facing the challenges of AI innovation and the climate change transition. At the same time, accumulated problems in Korean society have been appearing marked by a variety of social ills. First of all, Korea is facing rapid demographic change, including

an extremely low birthrate and a super-aged society. How this demographic transition is addressed will determine the country's future. Second, the country has a dual structure within its economy. It needs to address the wage gap between large and small companies, full-time and part-time workers, and the "Golden Ticket Syndrome" in young peoples' search for gainful employment. Third, AI innovation and climate change present both risks and opportunities, and Korean firms must capitalise on these through technological innovation. Fourth, the country must find ways to proactively respond to supply chain reorganisations while maintaining foreign trade in the face of increasing global uncertainty. Fifth, the country should create an environment that encourages its youth to take on the challenges of innovative start-ups by reorganising social processes.

In the meantime, Korea must endeavour to stabilise its macroeconomy amid rising global uncertainty. This is because stable management of the macroeconomy is the basis for ensuring stable growth, as it mitigates uncertainty, supports mid- to long-term decision-making, strengthens resilience in times of crisis and restores trust. In particular, the country must stay attentive to the following aspects: the deteriorating balance sheets and debt accumulation of both its government and private sector due to its aging population and political populism; the delayed rebalancing of trade and foreign investment with escalating strategic competition between the US and China; the lack of a response to population decline and the resulting needs for industrial restructuring; the delays in its transition to a productivity-driven economy centred on creativity, innovation, openness and cooperation; the neglect of income inequality and the escalation of social conflict; and insufficient preparation for future risks, such as climate change and inter-Korean integration (Cho, 2023).

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How can the Indian Tiger Realise its Potential?

Christian Ketels

India has often been seen as a nation of the future. But while the country's large potential is undisputed, its complexity has repeatedly created significant barriers to realising it. Building on the Roadmap for Better Growth – India@100, this study concentrates on what India should focus on to realise its potential. This roadmap is informed by an analysis of India's current competitiveness, looking both at its strengths and its weaknesses. Analysing these different facets of India is valuable for two reasons: First, India will inevitably play an increasing role in the global economy, and thus understanding its trajectory is important for tracking the future globally. Second, the challenges that India is facing are shared by a range of other developing countries, especially in Africa. Examining India's options to address these challenges will be valuable for them as well.

Journal of Economic Literature (JEL) codes: D04, F63, O14, O53

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1 Setting the scene

If one wants to look for a ray of hope in an otherwise quite bleak global economic outlook the sight inevitably falls unto India. In a world where long-term growth projections are generally being

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scaled back (Kose & Ohnsorge, 2024), India is seen as having strong growth potential, both in the short term (International Monetary Fund, 2024) and the long term.

But India has been there before (Huang & Khanna, 2003). It has long been seen as the country of the future, only to then not quite live up to this promise. Unfortunately, the public debate now seems to be focused on whether India's growth to become one of the world's preeminent economies in the near future is inevitable or mere hype (Mody, 2023).

This paper takes a different perspective. Building on the *Roadmap for Better Growth – India@100* (Ketels et al., 2022), it concentrates on what India should focus on to realise its potential. Nothing is ever entirely inevitable in economic development. India clearly has significant opportunities, but these will only translate into actual growth and prosperity when active steps are taken to exploit them. India has also already made more progress than many give the country credit for (Kant, 2023), especially some observers in the West who remain stuck with outdated perceptions of the country. However, this does not mean that the remaining obstacles ahead are trivial. The government has launched many policy initiatives in recent years (Panagariya, 2018), but are they enough or the right ones to ensure future success? This is a question that the pride in India's achievements and potential should not overshadow.

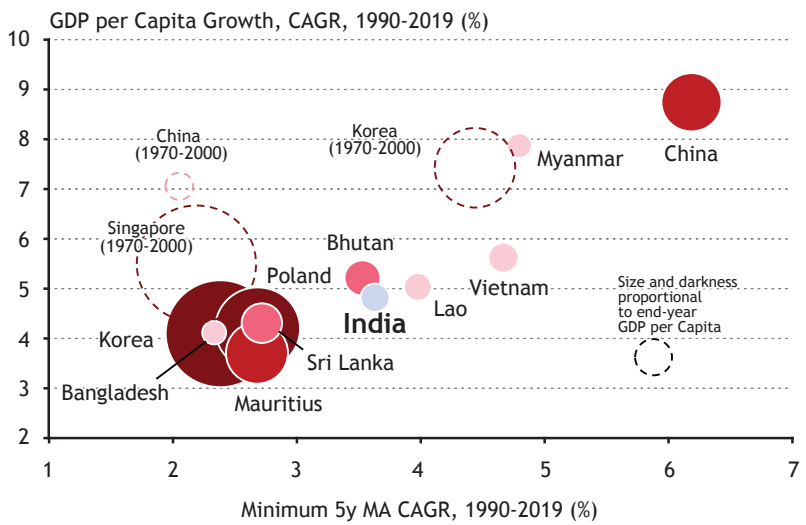
The roadmap was developed in response to the vision of Prime Minister Modi to push India towards a growth path that ensures India's transformation into a middle-income country by 2047. It takes a broad view of the goals that India has set for itself and then defines new principles for India's development approach, identifies new policy priorities and outlines a new architecture for implementation.

2 India's current competitiveness

2.1 Performance

India is one of the small group of countries globally that has achieved high and sustained economic growth over the last few decades. This strong growth has been overshadowed in the global perception by the even stronger growth achieved by China. The gap between these two Asian powerhouses is both clear and worth studying. But it should not distract from the fact that India's performance itself has been remarkable.

Figure 1. Global leaders in sustained prosperity growth



Source: World Bank

India left the period of minimal growth behind in the early 1990s. The reforms of 1991, enabled (or rendered inevitable) by a current account crisis driven by external shocks, marked a visible transition to a new period of Indian economic policy (Panagariya, 2003). Growth (and changes in policy) had already started to emerge in the preceding years (Rodrik & Subramanian,

2004), but the 1991 reforms overcame the limitations of reform by stealth (Das, 2012).

Growth accelerated over time, but then slowed in the years prior to the pandemic shock. There is a lively debate about the reasons for this slowdown and the implications it has for India's future growth potential (Subramanian & Felman, 2019; Basu et al., 2014; Chodorow-Reich et al., 2019). One key question is whether the slowdown was the result of macroeconomic imbalances or of policies that moved India away from the path towards higher competitiveness. What is clear is that the relatively modest level of investment is a critical concern and will have to be overcome for India to reach its potential. If macroeconomic reasons are to blame, low investment reflects limits in capital supply. Balance sheet imbalances at banks and corporates reduce their ability to finance investment. If policies eroding competitiveness are to blame, low investment reflects barriers to capital demand. Companies do not see opportunities for profitable growth that would require investment.

Following the growth of recent years, India is now a lower middle-income country with average prosperity levels at USD 2,000 (USD 7,150 at purchasing power parity). A closer look reveals a complex mix of gains and remaining challenges.

Poverty has fallen over time; by how much remains a topic of intense debate (Sandefur, 2022; Rangarajan & Dev, 2020). The pandemic pushed millions back into poverty and was a painful reminder of how vulnerable many Indians remain to economic shocks.

Inequality has increased with very high gains at the top of the income distribution; even here the specifics are debated (World Inequality Database, n.d.; Dang & Lanjouw, 2021; Chancel & Piketty, 2017). In any case, progress at the top is not an issue if it reflects higher value creation at the top end of the economy. But the low level of progress at the bottom of pyramid is.

In this context it is worrying that inequality appears to be strongly entrenched, with India scoring low on measures of social mobility (World Economic Forum, 2020). Social progress remains affected by marked weaknesses in environmental quality and the quality of basic education (Social Progress Imperative, 2024). As we discuss later, these performance challenges are present despite a clear political focus on enhancing the livelihoods of average Indians and many improvements to social policies that have become less distortive and more targeted.

Prosperity can be decomposed into productivity and labour mobilisation. India's productivity growth – measured by changes in GDP per employee – has been robust and tracked overall GDP dynamics. Productivity levels remain modest, and there are clear challenges, but it is important to note that these challenges are to a large degree not unusual for a country at India's stage of development. India is facing a more unique challenge in labour mobilisation. Labor mobilisation rates are extremely low, especially for women, and have been falling over time, especially since 2005 when job creation decreased dramatically. The latest data show more robust job creation, but it is too early to tell whether this is merely driven by short-term macroeconomic dynamics at the tail end of the pandemic.

Low productivity and the lack of job creation can be traced back to the structure of the Indian economy (Alfaro & Chari, 2014): the sectoral transformation from agriculture to industry has been relatively slow, especially in terms of employment. India's apparent relative advantages in labour-intensive industries have not translated into economic activity (Amirapu & Subramanian, 2015). Instead, the country has specialised in services, particularly skill-intensive IT services. The majority of employees are stuck in small, old, low productivity, and low growth firms, while there is a significant 'missing middle' (Ayyagari et al., 2013). Large firms have driven productivity growth, but not job creation.

Both issues have been long-standing concerns (Hsieh & Klenow, 2009; 2014). The pre-1991 policy mix of heavy regulation on companies, especially larger ones, and labour markets provided a clear explanation (Anand & Khera, 2016). But the persistence of these issues raises additional questions, given that many of the restrictions have been reduced over time. Path dependency and changing external conditions might play a role; other countries have established positions in labour-intensive industries and technological change has reduced the benefits of low labour costs (Hallward-Driemeyer, 2017). However, neighbouring Bangladesh has been able to succeed in the textile and apparel sector despite similar circumstances. New analysis of this sector points to the unintended consequences of Indian policies, especially trade barriers affecting the cost of key inputs (Anand & Thomas, 2022). Some regulatory barriers to firm growth have been removed (Martin et al., 2014), and labour markets have been liberalised recently. But there is evidence that companies are now struggling to find the skilled labour they need to break away from the low skill/low wage/low formality equilibrium of the past (Kapoor, forthcoming).

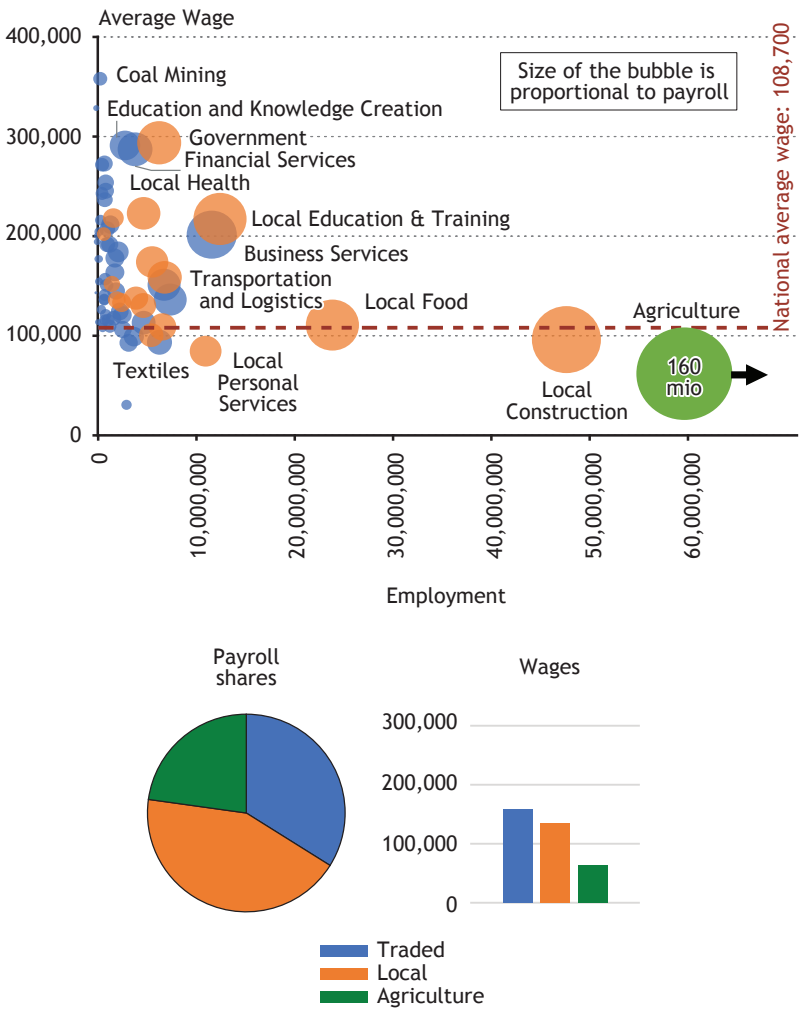
India has become fully integrated into the global economy through significant trade and FDI linkages (Chatterjee & Subramanian, 2020a). The inward-looking India is to a large degree a picture of the past. However, concerns about the benefits India has been able to generate from trade liberalisation have more recently led to a shift towards more protectionism or at least the stagnation of liberalisation efforts (Chatterjee & Subramanian, 2020b; Krishna, 2019). India's capital and knowledge stocks are in line with the country's current level of development, but provide limited pull for reaching higher. However, the trend of decreasing investment intensity in both capital and knowledge over recent years is worrying.

2.2 The many Indias – De-averaging across regions and sectors

For a subcontinent like India, a national average can easily be misleading. Economic and social outcomes across India are indeed highly heterogeneous. Performance differences appear entrenched with few if any signs of systematic convergence (Chanda & Kabiraj, 2020; Anshuman & Mehra, 2021; Nayak & Sahoo, 2022). A small group of regions accounts for a large share of national output and dominates activities such as exports and innovation (Amirapu et al., 2019). A large number of less prosperous regions appear largely unconnected to the modern Indian and global economy. Differences in business environment quality are significant as well and drive both sectoral mix and performance across and within sectors. Many aspects of business environment quality are driven by state-level policy choices; enabling and supporting effective choices at this level of government is critical for India to make progress in upgrading its competitiveness.

India's economy is an economy of clusters, i.e. geographical concentrations of related and supporting industries in specific fields of the economy. In many cluster categories, national value creation is dominated by a small share of leading districts (Ketels et al., 2023). Differences in cluster mix across regions are large. Cluster mix is systematically related to economic performance, but every location is also unique in its composition. The most prosperous locations are focused on traded clusters and are specialised in cluster-categories with the highest average wage levels. Traded clusters are economic activities that compete across locations and can choose where to operate. While in other countries, local sectors report significantly lower wages and skill intensity than traded clusters, these gaps are more limited in India. Especially local government, health care, education and utilities register high wages; education and health care also high skills.

Figure 2. India's cluster portfolio



Source: PLFS, team analysis

Urbanisation levels, across countries strongly related with rising productivity and prosperity, have been rising in India, but remain below the level of peers. Internal migration flows are reported as relatively modest in international comparison and appear focused

on movements within rather than across states (Bell et al., 2015; Kone et al., 2017). Cultural factors might play a role in driving these outcomes, with many Indians staying in locations where their caste and religious group provides a natural safety net.

2.3 India's competitiveness fundamentals

India's competitiveness, as measured by many international rankings, is significantly ahead of its economic performance. India's competitiveness score as measured by data from the *Global Competitiveness Report* matches China, while its prosperity is significantly lower. Conversely, India and Vietnam have roughly the same level of prosperity, but Vietnam reaches this outcome with significantly weaker competitiveness fundamentals. This may signal the potential for significant future growth. But it is more likely that these rankings reflect the reality for only a small share of India's firms, not the economy at large.

In many individual dimensions of competitiveness, India performs in line with its peers. But India suffers from a particular mismatch: factor input conditions around skills and infrastructure create opportunities primarily for firms that compete on low wages. But many administrative rules and regulations can only be met by companies that operate at a much higher level of performance. As a result, India fails to see the structural transformation it needs, and many companies remain stuck in informality and low scale.

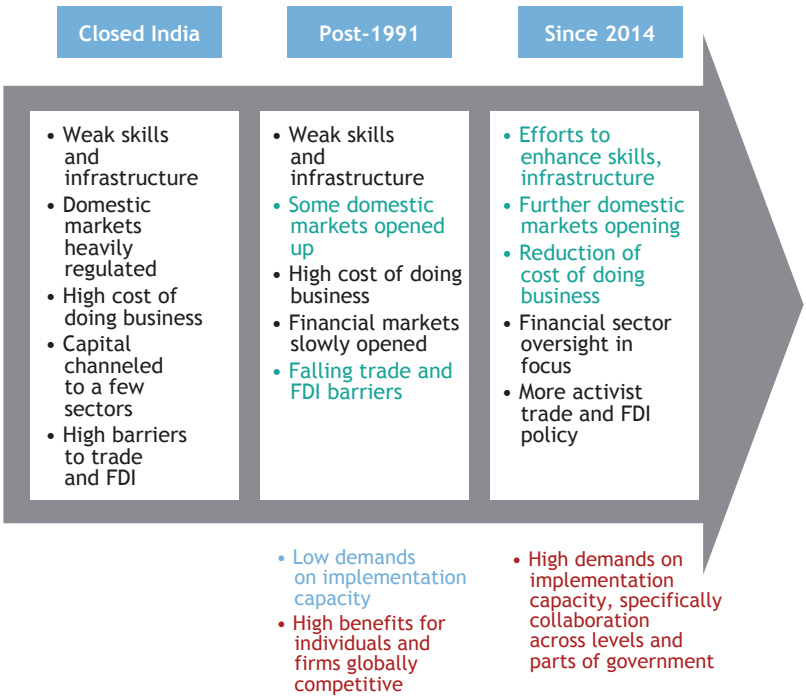
Another feature of this mismatch is that India performs surprisingly well in more sophisticated dimensions of competitiveness. But the country still lags in key fundamentals, in particular skills, some dimensions of infrastructure and the costs of doing business. Those parts of India's economy that already have the assets and capabilities to compete in the global economy tend to do relatively well. Those that depend on more

basic qualities of the business environment, however, find it hard to take the first steps towards the modern economy.

India has made headway on many factor inputs. In electricity, the country now provides sufficient overall generation capacity to serve nationwide demand. In education, enrolment rates are up as every Indian child is offered the opportunity to get schooling. But the benefits of these improvements too often fail to materialise because of distorted market structures or inefficient governance and incentive systems. In electricity, prices are subsidised for some groups but high for industrial users; many utilities are in financial distress and unable to ensure resilient and sustainable energy production. In education, educational attainment is deteriorating, and even poor parents pay for private schools with better service.

Policy action has been taken on many key dimensions of competitiveness, and the aims of these policies are generally consistent with what is needed to achieve higher competitiveness. But their impact is being hampered by insufficiently integrated reform agendas, policy actors working at cross-purposes, and a lacking runway from policy principles to implementation. There are also weaknesses in the development approach that fails to recognise the new realities of the global economy. One key challenge is the weak institutional capacity of the executive and judiciary and an often-ineffective public-private dialogue.

Figure 3. The policy implementation challenge



Source: Ketels et al. (2022)

3 Roadmap for Better Growth – India@100

3.1 The hill to climb: What will it take for India to realise its ambition?

India is a country that has shown its potential to deliver high and sustained economic growth. But India still classifies as a lower middle-income country. And while India will continue to grow based on its demographic profile and inherent growth dynamics, this current trend growth will not be sufficient to reach its goals

and potential. There is a long path ahead to realise its ambition to reach middle-income and eventually high-income status.

The competitiveness diagnostics have revealed three key challenges that India will have to address. First, the **shared prosperity challenge**: India's headline GDP growth had been strong and even accelerating until a pre-pandemic slowdown occurred. But weak social progress, rising inequality and a lack of convergence across regions suggest that for too many Indians failed to translate into the expected improvements in their quality of life. Second, the **jobs challenge**: India has a vast demographic opportunity with a young and growing working-age population. But it has increasingly struggled to create jobs for a large part of its labour force, especially for women and the less skilled. Third, the **policy implementation challenge**: India's government has pursued an ambitious agenda of economic reforms, largely focused on the appropriate issues and based on mostly sound conceptual principles. But the impact on job creation and the growth of firms has fallen short of ambitions. In addition, India is facing a **shifting external environment** with rising geopolitical tensions and changing patterns of globalisation, climate change and net zero-oriented policies, digital transformation and other technological changes – all in a complex macroeconomic context.

The "India@100" strategy proposes a set of new guiding principles, new priority policies and a new implementation model to achieve the transformation that India will need to reach its ambitious goals in view of these external circumstances.

3.2 New guiding principles

The guiding principles for the strategic roadmap are set by clearly defined overall goals and the articulation of a new development approach to get there.

India's ambition to achieve middle-income and ultimately high-income status puts **prosperity** at the centre of the proposed goals. The diagnostics have shown, however, that prosperity measured as average GDP per capita is insufficient. And Indian leaders have set goals on "Ease of Living," on regional development, on rapidly increasing renewable energy production and more. A range of four additional dimensions integrates these different aspects into an overall coherent articulation of India's ambitions:

– Prosperity growth needs to be matched by **social** progress.

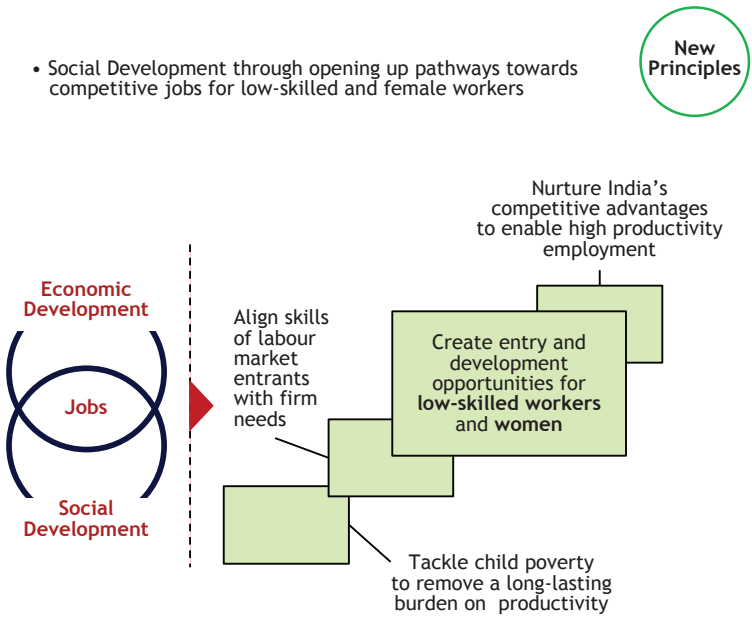
– Prosperity needs to be **shared** across all parts and regions of India.

– Prosperity growth needs to be environmentally **sustainable**.

– Prosperity needs to be **solid** and resilient in the face of external shocks.

India's development approach on how these goals will be achieved is based on two key principles. First, the **integration of the social and economic development agendas**. The "India@100" strategy pursues these agendas as mutually reinforcing and fundamentally connected through job creation. India needs to focus on enabling the creation of competitive jobs for those currently outside of the active labour market. Jobs that provide pathways to higher productivity will over time enable individuals to earn their own livelihoods and become self-reliant.

Figure 4. Shared prosperity through competitive jobs



Note: Current dichotomy:

- Improvement of social programmes, including job guarantee programmes through tech stack.

- Economic development via industrialisation.

Source: Own edition

Second, **"Structural Transformation 2.0"** as a portfolio-based approach for driving job creation across a number of service and industrial sectors (Ketels & Duch, 2022). Changes in technology and the structure of the global economy have reduced the power of the traditional growth model based on export-led industrialisation alone.

The immediate priority is to identify sectors with an ability to provide entry level opportunities and growth opportunities for those currently outside the active labour force, particularly low-skilled workers and women. While these jobs will initially have limited productivity, they provide the critical first step on a pathway to better jobs. There is also a need to systematically develop sectors aligned with India's current and future competitive advantages. While these industries will not provide jobs to the unskilled today, they will provide the source of jobs for a better skilled India tomorrow. Finally, there needs to be a set of policies targeted at children and young adults to provide them with the appropriate skills and capabilities for succeeding in the labour market.

3.3 New policy priorities

The "India@100" strategy translates these guiding principles into prioritised policy action. The first set of policies is focused on enabling **competitive jobs**. Competitive jobs earn their wages in the marketplace, support the livelihood of employees and provide opportunities for developing capabilities and productivity over time. For competitive jobs to emerge, India needs to reframe some of its industrial, regional, social and business environment policies. The second set of policies is focused on enabling the growth of **competitive firms**. Ultimately, there will be no sustainable job creation if India does not enable more productive firms to emerge and scale. India will need to strengthen and reframe its enterprise, competition and business environment policies to achieve this goal.

India needs to launch a new set of **sector- and location specific growth initiatives** to reframe some of its key industrial and regional policies. Sector- and location-specific initiatives can identify the specific needs of individual clusters and regions and then select from generic policy tools to pursue a coherent strategy

for growth and competitiveness upgrading. They will require tight collaboration between public and private sector leaders.

The process for identifying promising fields for such initiatives needs to be open, competitive and evidence-based. For low-skilled and female workers, critical criteria for attractive sectors are low entry barriers for women and low-skilled workers, market opportunities and the presence of existing competitive advantages. For higher productivity jobs, critical criteria include the evidence of existing competitive advantages, market opportunities and an alignment with the aspirations of India's national value proposition. Leading clusters can drive activities in the selected sectors.

Cluster categories with particular potential include health services, food and renewable energy production equipment. All of these provide opportunities for economic growth that provides also social and environmental benefits.

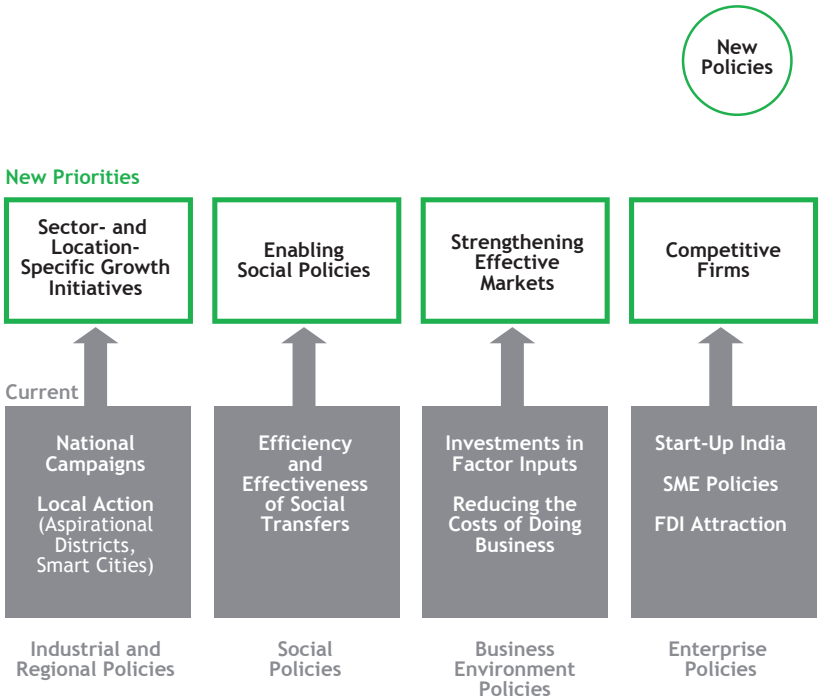
– In health services, India needs to increase its supply of services. The system already employs many women, but fails to leverage the large number of less-skilled Indians who could relieve higher skilled doctors and nurses to focus on areas where such skills are necessary. Here regulatory reform is critical to enable value-based health care in line with the realities of the Indian economy.

– In agriculture, there are opportunities for increasing exports and with it the livelihoods of farmers. Such a drive would also create jobs in many adjacent activities such astransportation, warehousing, and food production. A recent report to the XV. Finance Commission made a range of very concrete proposal to launch crop- and location-specific efforts in this direction.

– In renewable energy equipment production there is an opportunity to strengthen manufacturing while driving investments in carbon-free energy production. Collaboration with international partners could raise investment capital to quickly scale by ensuring critical market demand. India has

already provided significant incentives through its Production Linked Incentives (PLI) scheme and tariff protection.

Figure 5. New priorities for policy action



Note: Current approach:

- *Focus on inputs and lower cost of doing business; held back by inefficient market structures.*
- *Focus on start-ups, SMEs, and MNC investment; no pathways towards firm growth.*
- *Some enablement of local action; no coherent overall system that combines accountability with resources.*

Source: Own edition

India needs **enabling social policies** that enhance the employability of labour market entrants and reduce barriers to look for a job. These policies will address urgent social needs across the country and trigger job creation opportunities. In some areas this will require more resources, in others there is need for

regulatory change. Together they exemplify the opportunities from complementary social and economic development and move beyond the current welcome but insufficient focus on enhancing the efficiency of social programmes.

Childhood poverty and the lack of accessible healthcare services can result in stunting and other development impediments that reduce children's productive capabilities throughout their entire life. Low quality education and the poor fit of available skills with the needs of the Indian economy create huge barriers for labour market entry. The provision of childcare services and investments in public safety are often critical factors for women to consider looking for employment. In all of these areas, social policy is also an investment in economic development. Social policies that do not also trigger economic growth will likely require fiscal resources far beyond India's financing capacity (García-Escribano et al., 2021).

India needs to make **strengthening effective market competition** a more central element of its efforts to upgrade business environment conditions. Deeply distorted market structures across many sectors currently lead to poor outcomes, undoing the significant gains made in factor input conditions (Conway & Herd, 2009). The list of examples is long: electricity prices for industrial users are high, and utilities are unable to invest sufficiently in the transition to net zero energy sources given their weak balance sheets (Buckley & Shah, 2017). Agricultural market regulation purport to support farmers, but the overall impact of regulations is a sector with poor productivity and prices that are below international levels (Bolhuis et al., 2021). Educational outcomes are weak with no signs of improvement, despite an increase in enrolment rates and the number of educational institutions. Regulatory frameworks that are unfit for purpose and legacy market structures reminiscent of different times are holding India back.

Effective enforcement of competition policy requires an alignment with the new realities of digital markets and the existing market structures in India. Active policies to encourage entry and enable the scaling of competitive new firms are important given the imbalance between large incumbents and their fragmented competition. Market regulation needs to be used as a tool to encourage competition that encourages firms to compete on productivity. In markets with a strong role of government, robust governance and incentive structures are needed to mimic market dynamics. Across these policies, astute reform management that recognises the existing political economy of India is critical.

India needs to adopt a comprehensive approach towards enabling the growth of **competitive firms**. Enabling the growth of competitive firms will require deploying a range of supply- and demand-side policies, moving beyond current enterprise and industrial policies. The reduction of the regulations and labour market rigidities that historically kept firms small and informal will not be enough.

Infrastructure investments to build physical and digital connectivity are critical for firms to be able to access new markets. Regulatory reforms and improved effectiveness of the judicial system must be pursued to enhance the ease of doing business. Access to capital must be dramatically strengthened to enable investment and scaling, based on reforms of the Indian banking system that has weighed on investment rates (Acharya & Rajan, 2020). Market opening domestically (regulation) and internationally (trade policy) can create important new growth opportunities for companies as digitalisation reduces transaction costs of tapping into distant markets.

3.4 New institutional architecture

Competitive jobs created by competitive firms require a competitive government to provide an enabling business environment and policy context. India lacks neither ambition nor policy targets, but it does lack effective structures and processes to turn these political goals into real changes in the circumstances that firms face (Kapur, 2020). The path towards competitive government rests on effective coordination within government, capacity within government and coordination beyond government.

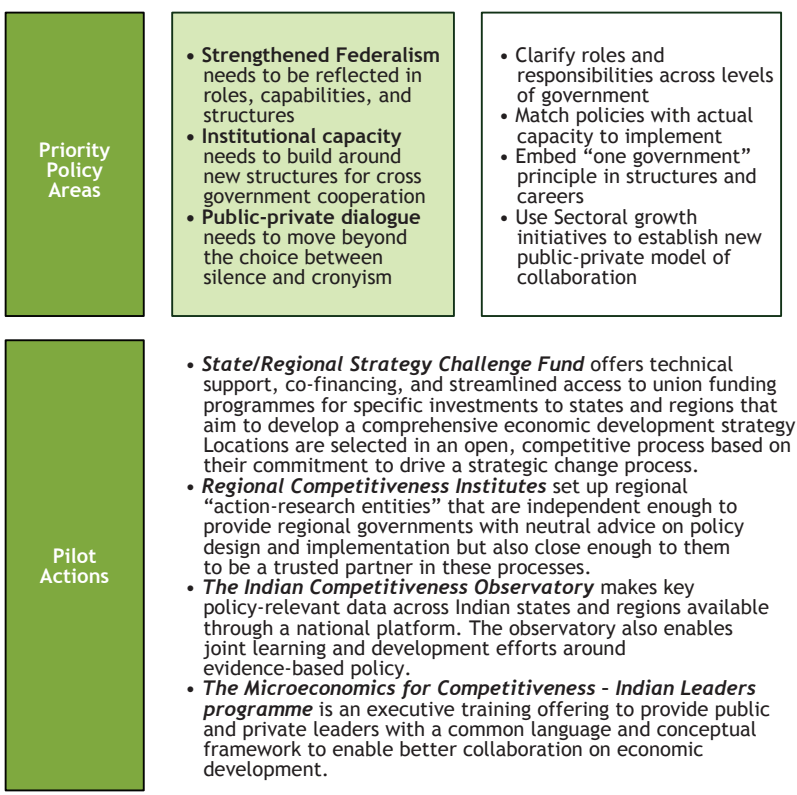
Strengthening **India's federal structure** is critical, given the size and heterogeneity of the country, and there is an increasing realisation that India needs more effective location-based policies. Recent reforms have increased the fiscal space for states, and there are interesting initiatives to encourage bottom-up initiatives (Reddy & Reddy, 2019; Chakraborty, 2019; Kelkar, 2019). However, there is no clear overall playbook for effective collaboration across levels of government in areas of concurrent policy authority. And despite the 74th constitutional amendment, there has been little if any effective decentralisation from state to strong local or regional entities.

India needs to strengthen **coordination within government** to overcome fragmentation in policy design and implementation. This will require empowering entities with coordination tasks. In the past, India had a more 'tiered' system of ministries that could be revived in specific areas. The government should also review its internal coordination mechanisms, including the creation of a national competitiveness council chaired by the Prime Minister and potentially embedded into Niti Aayog.[46]

[46] Niti Aayog replaced the Planning Commission, and is the central think tank of the government, chaired by the Prime Minister.

Public-private collaboration is critical for policies to be designed with a full understanding of the actual consequences they will have for firms and markets and for policy actions to be able to trigger complementary actions by firms. Public-private collaboration must be sheltered against the pressures of corruption and strive for narrow, firm-level benefits versus enhancements of overall competitiveness. Sectoral growth initiatives are an important testing ground for public-private partnerships. They could be supported by a powerful government agency with the ability to coordinate across policy areas.

Figure 6. Designing a competitive government
Policy Actions



Source: Own edition

3.5 From action plan to strategic agenda

As a strategic roadmap that aims to provide long-term direction, the "India@100" strategy needs to move beyond a current action plan of fixed policy initiatives to be implemented by designated parts of government.

To become an all-of-government agenda, ministries and agencies will need to review how their activities relate to the roadmap.

To be flexible, the roadmap will need to be a living document with regular reviews. New initiatives and responses to crises should be tested against their ability to support its goals, leverage its priority polices and draw on its new implementation model.

To provide guidance over the next 25 years, the roadmap's elements will play a different role over time. Priority policies will have an impact mostly in the near-term. The institutional model will influence the design and implementation of future policies. The principles can influence how India thinks about its circumstances and ways to improve when these circumstances look significantly different from today.

4 Implications for other countries

4.1 Learning from India

India has embarked on an ambitious development agenda, and given its size and nature it provides a critical case to understand the context that lower-middle income countries with high growth ambitions face in the current global economic context. In particular, African countries with a similar demographic profile face comparable economic policy issues.

The traditional growth model that worked well for China and other Asian economies was based on structural transformation, driven by export-oriented industrialisation. With low wage costs

as the key available advantage, these economies matched low-cost labour from their large agricultural sectors with the investment capital and technology of foreign multinationals. These countries became the workbench of the global economy, and key pieces of the global value chains serving markets in North America and Western Europe.

India did not follow this path, largely because of policy choices made in the past. The economy initially chose to largely separate itself from the global market, while also curtailing the domestic market through a wide range of regulations and public planning. The 1991 reforms marked a step change on the path to opening up the economy and paved the way for an acceleration of growth. But India did not embrace the export-driven growth model of East Asia, and its economy remained dominated by agriculture as well a growing service sector.

India's government now wants to change course and sees manufacturing as a key plank in the next stage of the country's development. But the question is whether this path is still open. New technologies make manufacturing less labour-intensive and more capital-intensive. Demand for manufacturing goods is growing more slowly than productivity, pushing down relative prices. Industrial policy actions by China and more recently the US and other OECD economies make it harder for new entrants to move into these industries (Aiginger & Ketels, 2024). Moreover, while exports have been an important contributor to Indian growth, job creation in manufacturing has been very limited.

In addition, the old growth model was strongly focused on generating growth, with social improvements and shared prosperity assumed to occur automatically. Environmental concerns were not at the centre of attention. The objective function for economic policy has now changed, also in emerging economies. Growth remains a critical concern, but it must provide opportunities across society and be aligned with sustainability.

Whether or not manufacturing-led growth is the appropriate strategy to achieve these goals is an open question.

India's trajectory and current situation outlined in this section provides an opportunity to reflect on how a successful growth strategy in this new context might look (Ketels & Kak, 2023). India is a particularly useful example, because it combines some success with the presence of clear remaining challenges. The country has achieved impressive growth, but the returns in terms of social progress have been limited and unbalanced. India has also improved its social policies, but while these policies reduce the costs of poverty, they do not address its root causes or provide a way out.

4.2 Dealing with India

India will play a pivotal role in the future of the global economy and community. Its demographic size and trajectory as well as its significant catch-up potential make India a likely key contributor to global growth over the coming decades. The profile of its growth, especially its resource intensity, will have a decisive impact on the global net zero transition. And the role India will play as a growing node in the global economy is likely to have a significant impact on what type of global economic system is going to emerge. Understanding the path that India is likely to take in all of these dimensions is thus critical, both for those who want to engage in the Indian market and for those who are affected by the broader dynamics of the global economy.

Perspectives on India are often shaped by the India of the past. Poverty, weak infrastructure, chaos and corruption, the dominance of coal in energy production, but also India's role as the world's IT back office are elements of this mental picture of India. This often leads to a view that India is in need of guidance from the outside and is likely to miss out on its potential as it has in the past. In response, an alternative perspective has emerged that focuses on India's future promise. It notes the country's demographic

opportunity, the growth of Indian IT start-ups, the changes in the Indian business environment that have occurred, the huge role the Indian diaspora plays in Silicon Valley and the many other assets India has access to. This often leads to a view that India's success is inevitable, and that the outside world should pay more respect to India rather than comment or criticise its development path.

As this section lays out, the emerging India is not well understood by choosing either of these perspectives in isolation. India's reality is a complex mix of progress and remaining challenges. Its future will be shaped by decisions and actions to be made, largely by Indian leaders themselves. The country has become self-sufficient in food production, but has a deeply distorted agricultural sector. Access to hard infrastructure has improved significantly, but market structures to deploy these assets are deeply distorted. The IT sector is strong and the top of Indian society is very educated, but this is still a small group within the overall population. The commitment to renewables is real and there is a full understanding of climate change, but also a need to provide affordable energy without becoming reliant on China as a technology provider. There are large implementation barriers due to distorted electricity sector and planning issues, while the government provides significant financial incentives to build up more zero-carbon energy capacity.

In dealing with India, other countries will have to revisit their traditional policy approaches. In trade policy for example, partners like the EU and the US have traditionally focused on gaining market access for their products and services in India, while providing opportunities for migration in return. Given India's impact on major goals these countries have, such as reducing CO_2 emissions and gaining access to new supply chain partners, a different approach should be considered: Europe has a stake in India's success and should thus consider how it can support trade and investment links that support India on this path (García-Herrero & Ketels, 2023).

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Sustainable GDP as an Indicator of Sustainable Competitiveness

Gergely Baksay – András Balatoni – Ádám Martonosi – Ágnes Nagy – András Zsolt Szabics – Ákos Szalai

Sustainable economic growth is inconceivable without an adequate level of competitiveness. Competitiveness and long-term sustainability are closely related concepts, because only what is sustainable in the long run can be competitive in terms of socio-economic development, and vice versa. The development of an appropriate measurement framework is key to assessing sustainability and competitiveness and formulating forward-looking proposals. While GDP is a good measure of output and value added in traditional sectors of the economy, it is limited in keeping pace with some new technologies, such as free digital services and cross-border activities. Moreover, the GDP methodology cannot and does not intend to measure competitiveness and the sustainability of economic performance achieved. The Magyar Nemzeti Bank published its Sustainable GDP – Global Discussion Paper in 2024, which aims to combine the measurement of economic development and sustainability in two ways. This paper presents the methodology and main results of these two indicators.

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1 Introduction

In retrospect, the early 2020s saw the end of a peaceful and prosperous decade worldwide, as the calm period after the financial crisis was followed by a series of global crises. In addition to the Covid-19 pandemic, the energy crisis and the surge in inflation, the escalation of geopolitical tensions is also pointing towards the transformation of the global economic system. In this rapidly changing, complex environment, it is increasingly important for all countries to sustain their economic growth and improve competitiveness. Competitiveness and long-term sustainability are closely related concepts, because only what is sustainable in the long term can be competitive in terms of socio-economic development, and vice versa (Matolcsy, 2020).

There is no sustainable economic growth without competitiveness. The available natural resources and human labour are not limitless: accordingly, continued and therefore sustainable economic growth can only come from reducing the overuse of resources and using resources more efficiently, in which technological innovation plays a key role. Therefore, countries must be set on a development model that focuses on improving quality factors (intensive) rather than quantity (extensive). Without this, the growth surplus of developing countries will be exhausted before they can catch up with developed economies (Magyar Nemzeti Bank, 2018).

To catch up successfully, competitiveness must also serve sustainability. Economic, social and environmental aspects

must all be taken into account. In their absence, the most that can be achieved is temporary growth, followed by stagnation or decline. Developing countries that are stuck in the trap of medium development are a good example of this process. In the last hundred years, only a few countries have been able to break out of this: in Europe, for example, Finland and Ireland, and in Asia, the "little tigers."

The development of an appropriate measurement framework is key to assessing sustainability and competitiveness and formulating forward-looking proposals. Today, the most important measure of economic development is gross domestic product (GDP), which was devised in the mid-1930s, primarily to measure the economic performance of industrialised countries. GDP is thus a good measure of the output and value added in traditional sectors of the economy, but it is limited in its ability to keep pace with some new technologies, such as free digital services and cross-border activities. Moreover, the GDP methodology cannot and does not intend to measure competitiveness and the sustainability of economic performance achieved.

GDP was the most important economic indicator of the 20th century, but today we need a compass that reflects the state of and changes in environmental, social and financial sustainability, in addition to the traditional dimensions of economic development. New indicators are needed to measure the sustainability of individual economies alongside their performance, and to take into account aspects not measured by GDP. In recent decades, several new indicators have emerged that have sought to quantify aspects beyond GDP, such as living standards, sustainability, competitiveness and well-being, in addition to material factors (Hoekstra, 2019; Stiglitz et al., 2018).

The Magyar Nemzeti Bank (MNB) is making continuous efforts to measure competitiveness and sustainability and is expanding the range of indicators to this end (Matolcsy, 2022). In the context of this work, the MNB published its *Sustainable GDP – A Global*

Discussion Paper in 2024, which aims to combine the measurement of economic development and sustainability in two ways (Baksay et al., 2024). The sustainable growth index is a composite indicator compiled according to the central bank's own methodology, which also incorporates sustainability aspects. The sustainable GDP indicator takes a different approach – adjusting existing actual-GDP by filtering out cyclical imbalances from the macro statistics, which can provide control for sustainability. The next two sections of the paper describe the methodology and main results of these two indicators.

2 The Sustainable Growth Index and its results

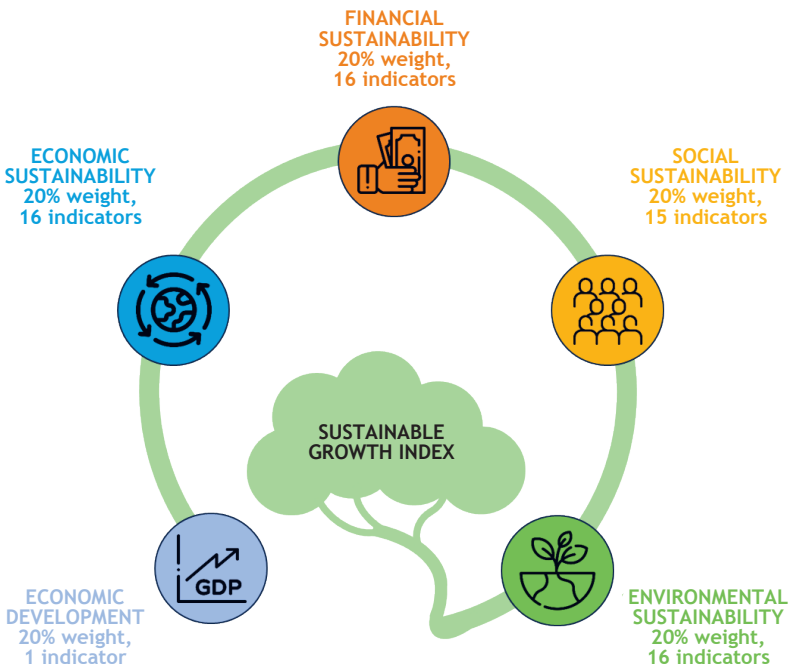
2.1 Methodology of the Sustainable Growth Index

The Sustainable Growth Index produced by the MNB consists of 64 indicators ranging across 4+1 pillars, yielding a composite indicator that assesses the sustainability of development in the EU Member States. The main objective of the MNB in creating the Sustainable Growth Index is to ensure that the relative value of GDP per capita, which measures the development of the economy, is adjusted to take into account sustainability aspects, in addition to the traditional economic dimension (Chart 1).

The MNB identified 4 main areas that are key determinants of sustainable prosperity: the areas of *economic*, *financial*, *social* and *environmental sustainability*. Of the 4 key areas, 15 indicators were analysed in the social domain, while 16 indicators each were analysed in the other domains, with a total of 64 indicators, including development, incorporated into the model. These indicators are all qualitative, structural indicators that determine sustainability in the long term, and the vast majority of them are objective. GDP per capita, which alone represents the development pillar, is complemented by subindices for each sustainability area.

The value of the main index is equal to the arithmetic average of the 5 areas under study, weighted equally. The analysis covers the period between 2010 and 2022 and territorially it includes the 27 Member States of the European Union (Baksay et al., 2024).

Chart 1. Structure of the Sustainable Growth Index



Source: Baksay et al. (2024, p. 155)

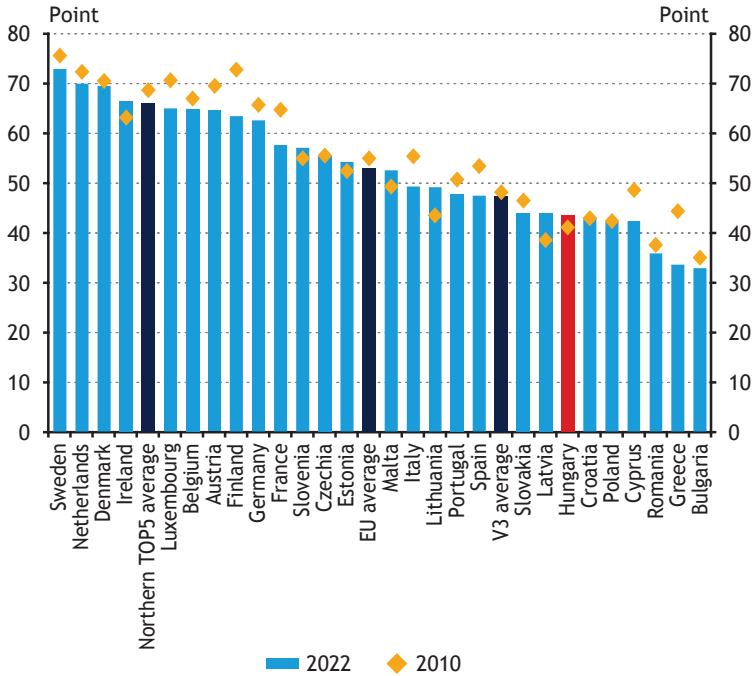
In compiling the Sustainable Growth Index, the MNB used its proprietary methodology. The calculation method first used in 2017 for the Banking System Competitiveness Index and later for the Competitiveness and Sustainability Indices, also forms the basis for the new composite index (Magyar Nemzeti Bank, 2020; 2021). In each case, the raw values of the indicators are converted to a score between 0 and 100 in the model, according to how each country's performance has evolved relative to the group of countries. The best-performing country scores 100 points, while countries ranked below this value in terms of performance

score fewer points in proportion to the deviation (Asztalos et al., 2017). The model gives us the option to choose the level of standard deviation at which a country is assigned a 0 score when transforming the data. With the parameterisation used by the MNB, values further away than four standard deviations are zeroed. One key issue in the scoring is the definition of the optimal value (e.g. minimum, maximum, average or specific target value), which varies from indicator to indicator and can in itself express what is considered a sustainable long-term direction for a given indicator. This study presents the cross-sectional performance of the EU countries compared to the average of the European Union, the Visegrád competitors and the Northern TOP5 countries (Denmark, Estonia, Finland, the Netherlands and Sweden), and also examines the performance of the countries in each domain and in the aggregate index over time from 2010 onwards (Baksay et al., 2024).

2.2 Results of the Sustainable Growth Index

According to the MNB's results, the Northern Member States performed best, while Hungary ranked 21st in the European Union in 2022 in terms of the Sustainable Growth Index (Chart 2). Overall, Sweden, the Netherlands and Denmark were the best performing of the 27 Member States, while Bulgaria, Greece and Romania were the worst performers. There was a large disparity in the index between countries, with Sweden scoring 73.1 points, as the best performer, and Bulgaria scoring 33 points, as the worst performer. The EU's average performance was 53.1 points, meaning that countries scored on average barely over half of the maximum 100 points, suggesting that all EU countries can improve their sustainability, albeit to varying degrees. Excluding Hungary, the average score for the three Visegrád countries was 47.4. In the region, the Czech Republic and Slovakia finished ahead of Hungary, while Poland was behind. The Hungarian score in 2022 was 43.8 points (Baksay et al., 2024).

Chart 2. Aggregate results of the Sustainable Growth Index

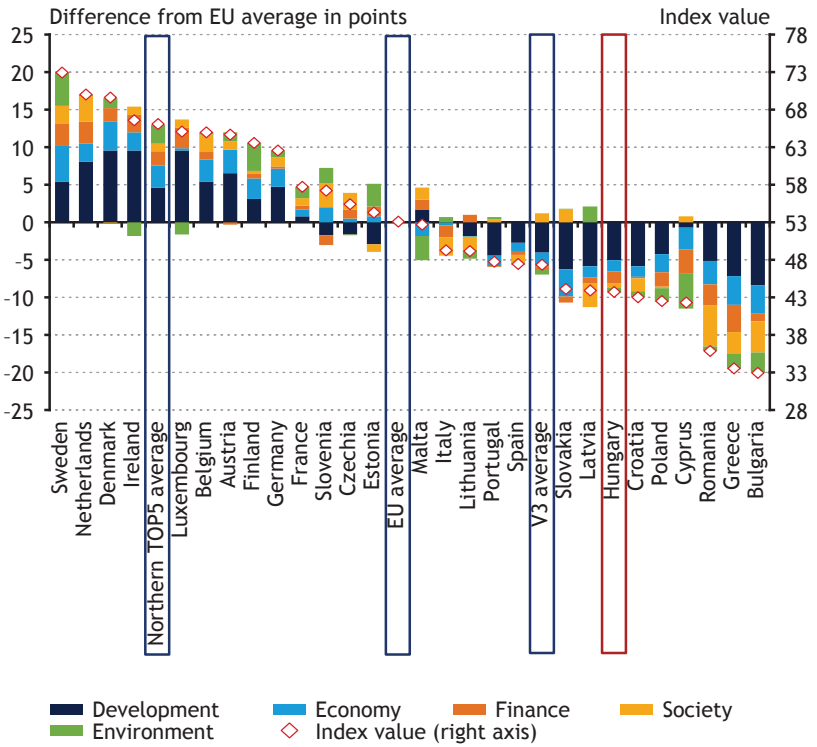


Source: Baksay et al. (2024, p. 222)

The countries with the highest scores in the Sustainable Growth Index have in common that they performed above the EU average in all 4 sustainability areas examined (Chart 3). Alongside Ireland and Austria, the Scandinavian and Benelux countries finished in the top 8 regarding the Sustainable Growth Index. The main feature of the group of countries is that in all the areas surveyed, the scores are typically higher than the EU average (with the partial exception of Ireland, Luxembourg and Austria). The general trend for the Central and Eastern European countries was that performance was varied at the level of the areas covered, both above and below the EU average. While these countries typically underperformed the EU average in the areas of development and economic sustainability, many scored above average in the areas of social and environmental sustainability. One common feature

of the SEE countries was that performance was below average, even significantly below average, in all of the sustainability areas examined (Baksay et al., 2024).

Chart 3. Breakdown of the Sustainable Growth Index by pillar contribution in 2022



Source: Baksay et al. (2024, p. 223)

Over the surveyed period of 2010 to 2022, 9 of the 27 Member States saw their sustainable growth index rise, while the performance of the most advanced Northern countries deteriorated, along with the EU average. According to the MNB's analysis, only one third of the countries have been able to increase their performance in the index since 2010, which means that only these countries have been able to move closer to what is considered the optimal long-term value. Taking the sustainability areas into account,

these 9 countries include Malta, Ireland and Croatia, in addition to the Central and Eastern European countries (Lithuania, Latvia, Hungary, Slovenia, Estonia, Poland). Of the former, Malta and Ireland are notable for their improved performance in sustainability areas, in addition to already being more developed than the EU average (Baksay et al., 2024).

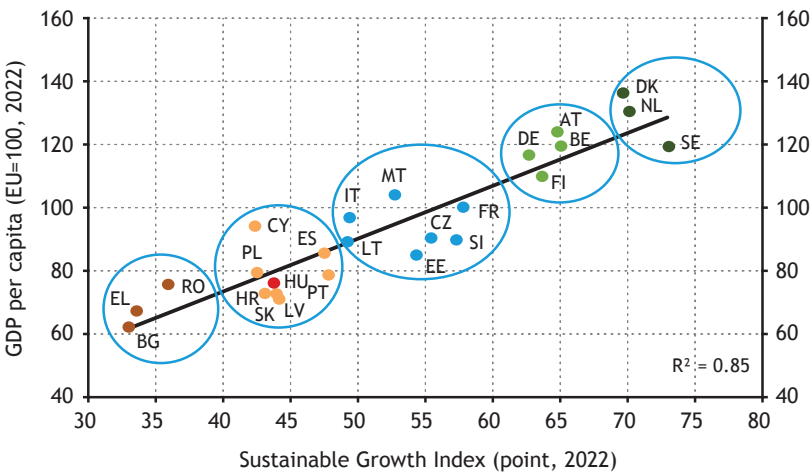
Based on the change in the score between 2010 and 2022, Hungary (+2.6 points) recorded the 5th highest increase in the Sustainable Growth Index, in line with which the country's relative position also improved from 24th to 21st place. In terms of improvement, Hungary is preceded only by Lithuania (+5.6 points), Latvia (+5.4 points), Malta (+3.3 points) and Ireland (+3.3 points). By contrast, the countries with the highest drop in scores over the period are Greece (-10.9 points), Finland (-9.3 points) and France (-7.1 points). The most advanced Northern countries also saw their scores fall compared to 2010, with Sweden down 2.8 points, the Netherlands down 2.4 points and Denmark down 1 point (Baksay et al., 2024).

Across the 27 EU Member States, a strong correlation was observed between relative development level and the Sustainable Growth Index (Chart 4), highlighting the importance of sustainability considerations in the process of sustainable convergence. European Union countries were classified into 5 groups based on their GDP per capita at purchasing power parity and the MNB's Sustainable Growth Index.[47] Among the top performers were Sweden, the Netherlands and Denmark, countries that stood out from the field regarding both indicators. They were followed by the developed Western European countries (Belgium, Austria, Finland, Germany), which performed well in both dimensions, but could not overtake the leading countries. The third group included Western European (France), Central and Eastern

[47] Ireland and Luxembourg are not included in this analysis because of their extremely high GDP values.

European (Slovenia, the Czech Republic, Estonia, Lithuania) and Mediterranean (Malta, Italy) countries. The fourth group included Mediterranean (Portugal, Spain), Central and Eastern European (Slovakia, Latvia, Hungary, Poland) and South-Eastern European (Croatia, Cyprus) countries, which were performing below the EU average. The last group, the fifth, included three countries (Romania, Greece and Bulgaria) that lagged significantly behind the others in terms of development, but especially in terms of the Sustainable Growth Index. The strong link between development and the Sustainable Growth Index confirms that strengthening sustainability is essential for a lasting improvement in Hungary's development and well-being (Baksay et al., 2024).

Chart 4. Relationship between Sustainable Growth Index and economic development in the European Union in 2022



Note: Ireland and Luxembourg are not shown here, due to their extremely high GDP per capita values.

Source: Baksay et al. (2024, p. 225)

2.3 Results of the sub-pillars of the Sustainable Growth Index

2.3.1 Economic sustainability

Sustainable growth depends not only on factors outside the economy (environmental conditions, demographics), but also on the capacity of the economy itself to grow. The main driver of economic growth is productivity growth, i.e. the increasingly efficient use of available resources. However, this requires the integration of complex development, basic research, innovation and the incorporation of productive investment into production, as well as well-organised production processes and the marketing of products in a highly competitive market. The economic sustainability pillar, as described above, includes indicators mainly describing productivity, investment, innovation and domestic value added.

The Northern countries and Austria are the best performing EU countries in terms of economic sustainability, while Greece, Bulgaria and Slovakia are at the bottom of the ranking based on 2022 data. Hungary ranked 20th among EU countries, slightly better than the average of the other Visegrád countries. Looking at the Baltic and Central and Eastern European regions, Estonia and the Czech Republic performed better than the EU average, while all of the Mediterranean countries performed below average. The top-ranked countries in economic sustainability are characterised by high levels of productivity, R&D spending and digitalisation, while the countries at the bottom of the ranking have low levels of productivity, digitalisation and investment rates. Since 2010, Latvia has shown the greatest improvement (6 places), but the other Baltic Member States, as well as Malta, Hungary and Slovenia, have also shown similar improvements (4 to 5 places) on the basis of the indicators analysed. The biggest drop in the ranking since 2010 was observed in Greece, which slipped 7 places since 2010 to last place in economic sustainability (Baksay et al., 2024).

2.3.2 Financial sustainability

Financial sustainability, based on a stable and efficient financial intermediation system and macroeconomic and financial market stability, is an essential factor for sustainable convergence in the long term. Efficient, diversified financing in a sound structure and financial balance promote not only economic, but also social and environmental sustainability. In the analysis of financial sustainability, several banking sector indicators (lending, profitability) and macro-financial indicators for the national economy, such as public debt or balance of payments, were taken into account, and the pillar also includes indicators on financial digitalisation.

In the area of financial sustainability, the Netherlands, Sweden and Luxembourg were the top performers, while Greece, Cyprus and Romania were the worst performers. The TOP5 countries in the Northern region, but also Estonia in the Baltic States and the Czech Republic in the CEE region, perform significantly better than the EU average. The performance of the Southern countries and most countries in Central and Eastern Europe, among others, is below the EU average. The best performing countries in terms of financial indicators tend to have current account surpluses, high credit penetration and a high degree of financial digitalisation. By contrast, economies with weak financial sustainability are characterised by current account deficits, low credit penetration and high non-performing loan ratios. Based on the financial indicators included in the study, Lithuania showed the greatest improvement in the EU ranking, moving up from 23rd to 10th place between 2010 and 2022. Along with Lithuania, Ireland also showed significant progress (10 places). Finland and France slipped the most (by 7 places) during the period, while Hungary advanced from 26th to 22nd place (Baksay et al., 2024).

2.3.3 Social sustainability

The quantity and quality of human capital has a fundamental impact on social and economic sustainability. In the long term, the quantity of human capital is determined primarily by demographic trends, while its quality is influenced by the effectiveness of the education system. The healthcare system and the lifestyle of individuals (healthy diet, regular physical activity) have an impact on both the quantitative and qualitative dimensions. In addition to the quantity and quality of human capital, the way in which it is used and rewarded by a society is also crucial, i.e. the state of the labour market, the degree of inequality and living conditions. Based on this, the subsection on social sustainability includes data on the quantity (e.g. fertility rate, employment rate) and quality (e.g. tertiary attainment rate, overall life expectancy) of human capital, as well as indicators on inequality and living conditions.

In terms of social sustainability, the Netherlands, Slovenia and Sweden top the EU ranking, with Romania, Bulgaria and Latvia at the bottom. The Czech Republic and Slovakia are among the countries that perform significantly better than the EU average, making society the only one of the four areas of sustainability where the Visegrád average is better than the average of the Northern top countries. The average performance of the latter group of countries is better than the EU average, while the performance of most of the Mediterranean, Baltic and Central and Eastern European countries is below the EU average. Common characteristics of the frontrunner countries suggest that low income and wealth inequality, widespread lifelong learning and low rates of young people neither in employment nor in education or training (NEETs) help to promote social sustainability. However, countries that perform poorly on social sustainability tend to have higher rates of inequality, persons at risk of poverty or social exclusion (AROPE) and low life expectancy. Between 2010 and 2022, Slovakia made the most progress (12 places) in the

EU ranking in terms of social sustainability, followed by Slovenia and Malta in terms of improvement (8 and 7 places, respectively). The biggest drop was in Finland, which has slipped from 3rd to 15th place since 2010. Hungary moved up 5 places since 2010 to rank 18th in 2022 (Baksay et al., 2024).

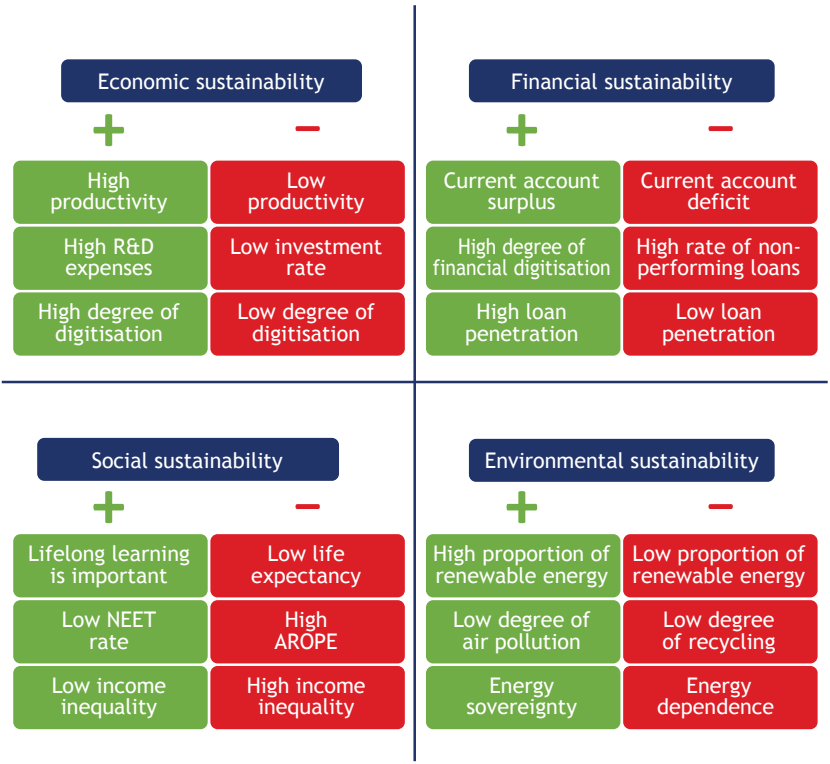
2.3.4 Environmental sustainability

The long-term sustainability of the economy and society can only be achieved if environmental considerations are taken into account in the decisions taken, as sustainable convergence is not possible without a green and circular economic transition. It is therefore of the utmost importance not to exploit the natural resources available to us, but to manage them efficiently and sparingly. Minimising emissions, developing an efficient and sustainable energy mix and strengthening green financing are essential for resource management. The environmental sustainability assessment therefore takes into account several indicators describing resource and energy management (e.g. water resources, greenhouse gas emissions, energy intensity) and also examines the evolution of financing for the green transition (e.g. environmental expenditure).

In terms of environmental sustainability, the top Northern countries – Sweden, Finland and Estonia – lead the EU ranking, while Cyprus, Malta and Bulgaria are the worst performers in this regard. Western European countries, among others, ranked above average, while Luxembourg and Ireland, along with Mediterranean and Central and Eastern European countries, performed below average. Hungary is ranked 18th in the EU in 2022, unchanged from 2010. The best performing countries in environmental sustainability have higher energy sovereignty, a high share of renewable energy resources and low air pollution. By contrast, based on the indicators examined, the countries at the bottom of the ranking are characterised by a higher energy dependency, a low share of renewable energy resources and low waste recycling. Since 2010, Latvia has made the most

improvement in the ranking of environmental sustainability (6 places), followed by the Czech Republic and Belgium (5 places each). The largest regression of 7 points occurred in the Netherlands between 2010 and 2022 (Baksay et al., 2024).

Chart 5. Factors that most influence the four dimensions of sustainability



Source: Authors' compilation based on Baksay et al. (2024)

3 Methodology and results of the sustainable GDP indicator

3.1 Sustainable GDP methodology

The sustainable GDP (sGDP) indicator produced by the MNB is an economically adjusted GDP indicator that shows the economic output that would be generated while balancing product and labour markets, the financial sector and the ability to finance, and preserving ecological resources, and at the same time ensuring a fair distribution of the goods and services produced. A further important aspect in the formulation of the indicator was for it to be comparable over time and cross-sectionally, so that the main trends over the last two decades can be seen. Accordingly, sustainable GDP is an indicator that measures the revised level of GDP, so the time series are readily interpretable and comparable across countries and also with the original GDP time series. Such indicators are less common in international practice, with composite indices predominating.

For each of the five areas selected by the MNB, a key indicator was defined to capture the deviation of the given variable from its equilibrium level – i.e. shorter and longer-term cycles – and these deviations were then used to adjust GDP developments. It was then possible to calculate what GDP would have been at each point in time if the economy had been on a sustainable path in these five dimensions. The result can be higher or lower than the GDP figure shown in the statistics. It is lower if the economy has expanded faster than the sustainable path, which can lead to overheating and imbalances, and it is higher if the economy has not exploited its equilibrium growth potential.

The level of sustainable GDP calculated by the MNB shows what the GDP value would be if there were no imbalances in the economy and all key variables were on a sustainable trend. If this is the case, i.e. if there is no significant difference between GDP per capita at purchasing power parity and the sGDP indicator

calculated by the MNB, then economic performance is sustainable at the given level.

The calculation of sustainable GDP must take into account different macroeconomic variables, the cyclical evolution of which have different wavelengths. The deviation of economic, social, and ecological processes from equilibrium levels should be measured in the following five areas, and the level of GDP should be adjusted by these differences (Chart 6).

– Business cycles have the shortest cycle length of 5 to 10 years, which we examine by the output gap. This captures the macro-level supply and demand relationship, so it can demonstrate if the economy is overheating and entail inflation risks, and also if output is below its potential level. The demand side of the economy is shaped by incomes, the outlook, the demand effect of the budget, the external economic activity and many other factors, all of which play a role in determining the output gap.

– We look at the current account statistics, which shows whether the economy's external balance with other countries is in balance. In the case of a deficit, the economy is temporarily using more resources than it has available, while in the case of a surplus, externalisation limits domestic growth opportunities and makes it more difficult to achieve global equilibrium. The external balance in a broader sense is captured by the current account, which includes financial flows. Within the European Union, an important point is that the above statistics do not include part of the financial flows with the EU, so the current account indicator, i.e. the financing capacity, has been used, supplemented by the capital account. The equilibrium position was considered to be a balanced (zero) financing capacity, which means that neither net external debt nor claims accumulate.

– Internal financial balance is measured by the credit gap. A positive value indicates that the banking system is lending more to the economy than is sustainable, which may stimulate economic growth in the short term, but is unsustainable even

in the medium term. In the case of a negative credit gap, the banking system lends less than it could, given its own development and the state of the economy, which slows down investment and thus economic growth.

– Social inequality is captured by the employment gap. The difference between the employment rates of the low- and high-skilled can measure the current state of social mobility, income inequalities and social cohesion. Since there is no optimal level of social inequality, we compare each country to its own level that appears historically sustainable.

– The environmental aspect of sustainability is quantified by the ecological balance, which is the difference between the natural resources (biocapacity) available in a given area and the resources used from it (ecological footprint). If the ecobalance is negative, the national economy uses more environmental resources than available in its territory in a renewable way. With the exception of the sparsely populated Scandinavian countries, EU countries typically have ecological deficits.

Chart 6. sGDP indicator with five sustainability aspects

Source: Baksay et al. (2024, p. 272)

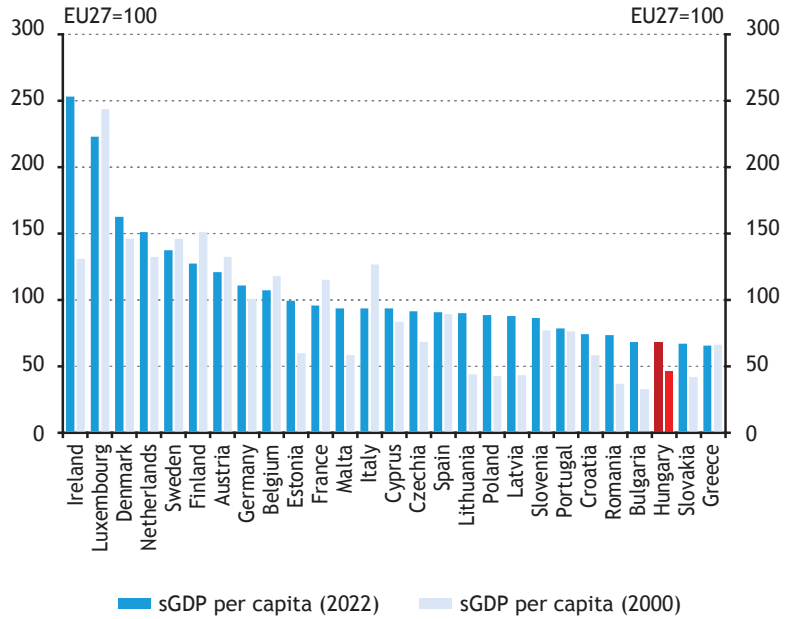
The limited number of variables used by the MNB allows us to perform these calculations over long time series (2000 to 2022) and for broad international comparisons (all 27 EU Member States). The main objective in compiling the sGDP indicator was to make it comparable with GDP per capita at purchasing power parity. Converting the total GDP of the national economy to GDP per capita helps to eliminate differences in size between countries. The purpose of purchasing power parity is to remove distortions due to different price levels in different countries.

3.2 Results of the sustainable GDP indicator

As with GDP per capita, sGDP per capita varies significantly across EU countries over the two decades or so under review. It is also similar to GDP in that there is convergence at EU level, mainly through the convergence of less developed countries. For many countries, sustainable GDP levels are significantly below or above the actual GDP levels over longer or shorter periods, suggesting that countries are experiencing significant imbalances.

Looking at the main trends over the last two decades, Ireland and Luxembourg stand out in terms of sGDP levels, due to their specific economic structure, similar to most economic statistics, followed by the advanced Western European and Northern countries. In the case of Denmark, the Netherlands and Germany, it is true that their sustainable GDP relative to the EU average has improved compared to 2000, while the other developed countries have seen a slight deterioration, mainly due to the performance of the less developed countries that are catching up dynamically. In terms of sGDP per capita, Poland has made the biggest improvement of all the Baltic countries. Estonia is ranked 10th, partly due to its favourable ecological balance. The role of the ecological balance also makes a significant contribution to sustainability in other, typically Northern countries, with untapped biological capacity improving sGDP to a lesser extent in Latvia and to a great extent in Finland and Sweden (Chart 7).

Chart 7. Trends in sGDP per capita in Europe (EU27=100), 2000 and 2022



Source: AMECO, Eurostat, Global Footprint Network, York University, IMF, BIS, ECB, MNB calculation

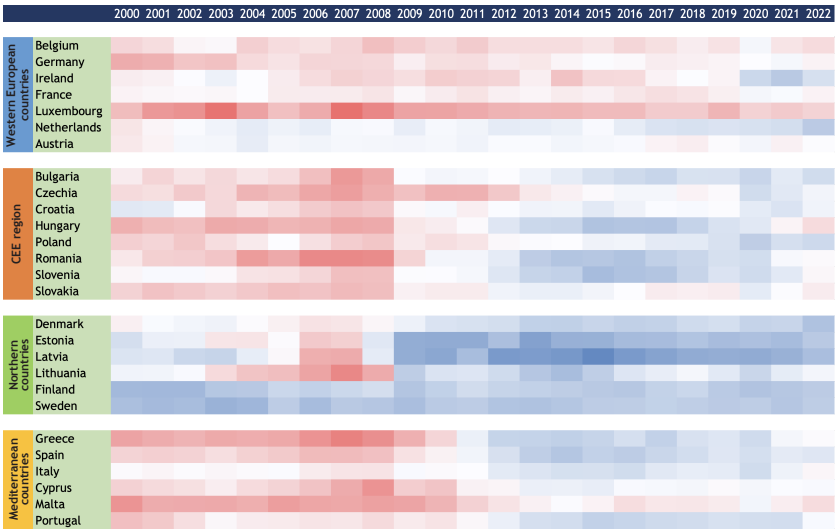
The sustainable GDP indicator calculated for EU countries shows common trends despite differences between countries. Sustainable GDP was lower than the GDP of most Member States in the early 2000s, and this gap peaked in 2007. The indicator therefore signalled the imbalances that led to the financial crisis that began in 2008 and deepened this crisis. The fall in GDP and strong balance sheet adjustment led to an increase in sustainable GDP relative to the traditional measure following the financial crisis. This was particularly true for the Central and Eastern European and Mediterranean countries and the three Baltic states (Chart 8). In the second half of the decade, sGDP ratios returned to above GDP in most EU countries, but no significant imbalances emerged.

The character of the 2020 decade is very different from the previous one. The global pandemic, the energy crisis and the geopolitical realignment have hit the European economy at sensitive points, upsetting previous balances and undermining the conditions for sustainable growth. In 2020, the level of sGDP fell widely, and in around half of EU countries it was still below the traditional GDP level in 2022. However, a group of well-performing countries managed to improve their position even compared to 2019, with mostly Northern countries (Finland, Sweden, Denmark, Estonia, Latvia) among them, where a positive ecological balance significantly improves sustainability. In addition, the Netherlands, Poland and Bulgaria performed well despite the challenges of recent years (Chart 8).

Hungary followed a path similar to most European countries over the past two decades. In the 2000s, economic growth occurred at the expense of equilibrium, so that sustainable GDP remained consistently below the level of statistical GDP. However, the innovative reforms implemented in the early 2010s ensured that economic balance and growth were maintained at the same time, and as a result, the Hungarian economy achieved significant growth in the 2010s, not only in terms of traditional GDP, but also in terms of sustainable GDP. The crises of the 2020s decade have caused Hungary's sustainable GDP to fall below the level of GDP in 2021, and the gap remained negative in 2022 as well.

For sustainable development and convergence, a complete competitiveness turnaround is therefore needed in both Europe and Hungary in the future, including accelerating the green and digital transition and all measures that will permanently increase the value-creating capacity of the economy.

Chart 8. Difference between sGDP and conventional GDP in the European Union (2000–2022)



Note: The red shading indicates years when GDP was higher than sGDP and the blue shading indicates the difference with the opposite sign.

Source: AMECO, Eurostat, Global Footprint Network, York University, IMF, BIS, ECB, MNB calculation

4 Summary

Competitiveness and long-term sustainability are closely related concepts, as sustainable economic growth cannot be achieved without competitiveness. In both areas, economics is struggling to develop an appropriate measurement methodology, which is key to both sustainability and competitiveness development. Traditional statistics based on GDP have considerable limitations in answering this question, and although there are a number of internationally known alternative measurement methodologies, no standard statistical approach has yet emerged that is capable of addressing the problem. In 2024, the Magyar Nemzeti Bank

published its Sustainable GDP – Global Discussion Paper, the main message of which is that economics needs a sustainability turnaround and new metrics to monitor this turnaround. It includes two new indicators of the MNB to measure sustainable economic performance. Of these, the Sustainable Growth Index quantifies sustainable growth using a composite index in line with international practice. The other methodology, sustainable GDP, builds on macro-statistics using a narrower set of variables and uses them to define sustainable GDP as the level of actual GDP adjusted for cyclical imbalances. Both methodologies have produced meaningful results to measure development trends and gaps in European countries and their relative performance. Based on the results, a competitiveness turnaround is needed in Hungary and across Europe to promote economic convergence and sustainable development, including accelerating the green and digital transition and improving the value-creating capacity of the economy.

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Chapter 3

‘Technovation’ – Technology and Innovation Driving Sustainable Economic Policies

Instant Payment Systems in Asia

Levente Horváth

The adoption of instant payment systems across Asia has revolutionised financial transactions, offering unprecedented speed, accessibility and efficiency. Early adopters such as Japan, South Korea and China pioneered the trend in the early 2010s, leading to widespread implementation across Asia by the late 2010s. Systems such as Thailand's PromptPay and Singapore's PayNow have set benchmarks for real-time payment efficiency. Furthermore, collaborative efforts to interlink systems across Southeast Asia aim to facilitate seamless cross-border payments, enhancing regional economic integration. This study examines the development and impact of these systems in key regions of Asia. The findings underscore the transformative potential of instant payment systems in fostering digital economies and financial inclusivity.

Journal of Economic Literature (JEL) codes: O53

Keywords: instant payment system, Asia, China, South Korea, Japan, ASEAN, Russia

1 Introduction

In the 21st century, we are witnessing the industrial revolution 4.0, which also affects the financial field. FinTech, blockchain, digital central bank currency, etc. are increasingly emphasised. This also

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includes the instant payment system (IPS), which gave a huge boost to the development of financial relations (Pal, 2022).

In today's fast-paced digital economy, the need for rapid and efficient financial transactions has never been more critical. Instant payment systems, which enable the immediate transfer of funds between accounts at any time, have emerged as a transformative technology in the financial sector. These systems have revolutionised the way individuals and businesses conduct transactions, offering unparalleled speed, convenience and security.

Asia, a region characterised by diverse economies and technological innovation, has been at the forefront of adopting and implementing instant payment systems. From China's ubiquitous mobile payment platforms to India's groundbreaking Unified Payments Interface (UPI), Asian countries are leveraging instant payment technologies to enhance financial inclusion, drive economic growth and foster a digital economy.

This essay explores the landscape of instant payment systems in Asia, examining their development. It provides a comprehensive overview of the various systems in place and their operating principles, as well as the historical context that has shaped their evolution. Additionally, the essay compares the performance and adoption of these systems across different Asian countries, identifying the key factors contributing to their success and the challenges they face.

2 Overview of instant payment system

2.1 Background

Settlement of payments was originally based on the check clearing cycle, which required banks to exchange physical checks at clearing houses for payments between bank accounts. When

electronic payments entered banking systems starting in the 1970s, the same time frames and processes were used to complete these electronic payments.

From the late 1960s to the 1970s, significant progress was made in electronic payments. Barclays Bank introduced the first Automated Teller Machines (ATMs) in the UK in 1967, soon followed by Chemical Bank in the US in 1969. The Automated Clearing House (ACH) was officially established in 1972. SWIFT (Society for Worldwide Interbank Financial Telecommunication), founded in Belgium for cross-border payments, came into operation in 1977. These technologies were further developed in the 1980s. With the advent of the Internet and digital technology in the 1990s, however, electronic payments developed at the speed of light (Montevirgen, n.d.).

The growth of e-commerce since the 2000s has caused a change in people's spending habits and expectations. Shopping is no longer limited to regular business hours, creating new challenges for transfers. Likewise, merchants need a faster and more reliable money transfer system to keep up with consumer demand. Traditional electronic payments, such as bank transfers, which complete the electronic funds transfer within a few business days, do not meet user expectations. Therefore, in more and more countries, work began to develop the instant transfer system, which became natural within a short time (Hartmann et al., 2019).

2.2 Instant payment system

Instant payment systems, also known as real-time payment systems, are financial systems that allow money transfers to be made and received almost immediately, typically within seconds. These systems operate 24/7, 365 days a year, providing continuous availability for users to send and receive funds instantly.

Salmony (2017) reviews a wide range of potential industry applications and concludes that, despite their high initial cost,

instant payments are likely to bring significant value to customers. Hayden and Hou (2015) examine the potential business applications of an instant payment platform and, among other things, describe interbank mobile payment as an important development.

In addition to these aspects, the key features and benefits of IPS can be summarised as follows:

Key features of IPS:

– **Speed:** Transactions are processed and funds are transferred in real time, typically within seconds.

– **Availability:** The systems are operational around the clock, every day of the year, including weekends and holidays.

– **Irrevocability:** Once a payment is made, it cannot be reversed, ensuring the finality of the transaction.

– **Convenience:** Users can initiate and receive payments at any time using various channels such as mobile apps, online banking or point-of-sale systems.

– **Security:** These systems employ robust security measures to protect against fraud and ensure the integrity of transactions.

Benefits of IPS:

– **Enhanced cash flow:** Businesses and individuals can manage their cash flow more efficiently with immediate access to funds.

– **Improved customer experience:** The ability to send and receive money instantly enhances user satisfaction and trust in the financial system.

– **Reduced risk:** Immediate settlement reduces the credit and settlement risks associated with delayed payments.

– **Financial inclusion:** Instant payment systems can provide access to financial services for unbanked and underbanked populations, particularly through mobile payment solutions.

Instant payment systems are transforming the way financial transactions are conducted, offering a faster, more efficient and secure alternative to traditional payment methods.

3 Development of instant payment systems in Asia

Instant retail payment systems have been developed in many countries around the world, and the number of such services is growing rapidly (FIS, 2017). This study reviews the use and development of instant payment systems in Asian regions. First, the East Asia region is presented as the initial users of the instant payment system, followed by Southeast Asia and South Asia, and finally the other regions will be discussed.

3.1 China, South Korea and Japan

In the past decade, the adoption of instant payment systems in Asia has spread significantly. Countries such as Japan, South Korea and China were among the early adopters, introducing their systems in the early 2010s. South Korea introduced its real-time payment system in 2012, followed by Japan in 2013. China launched its own system around the same time, driven by the rapid growth of mobile payments and the need to process transactions faster.

China

China boasts one of the largest and most developed financial systems in the world. In recent decades, it has undergone a significant transformation through economic reforms and technological development. The country has developed a strong

banking sector, a vibrant capital market and a fast-growing FinTech industry. Since the 2011 financial sector assessment programme (FSAP), China's economic growth has remained strong, although a necessary economic transformation is underway (World Bank, 2017). The integration of technology into financial services has significantly increased efficiency, accessibility and inclusivity. China's financial sector is currently the largest in the world, with assets of USD 60 trillion (as of 2023) (García-Herrero, 2023), equivalent to 340% of GDP. Chinese banks also lead the list of the largest global systemic financial institutions, which increasingly interact with the rest of the global financial system.

China started implementing the Instant Payment System (IPS) more than a decade ago. The Internet Banking Payment System (IBPS) was launched in August 2010, as part of Second Generation of China National Advanced Payment System (CNAPS II) by the People's Bank of China (PBoC). IBPS has spread rapidly in China. It is now widely used across the country and processes millions of transactions daily. The system is integrated with major payment platforms such as Alipay and WeChat Pay, which are almost ubiquitous in Chinese daily life. This has enabled seamless and instant financial transactions, be it retail purchases, utility bill payments or person-to-person transfers.

China's real-time payment market size is estimated at USD 5.46 billion in 2024 and is expected to reach USD 22.38 billion by 2029, a forecast growth of 32.60% (Mordor Intelligence, 2024). According to the report published in March 2023 by CNNIC (China Internet Network Information Center, 2023), China had about 1,067 million internet users and of these about 80% shopping online (about 845 million people). A significant rise in the number of real-time payment transactions in the region is expected to further increase real-time payments.

In China, the commercial banks are using the IPS, but the biggest – and also world-wide well-known – IPS platforms in China are Alipay and Wepay:

– **Alipay**: Alipay is an online payment platform launched in China in 2004 by the Alibaba Group, an international e-commerce giant that has been integrating physical store payments for some time. The platform is similar to other digital wallets such as Apple Pay or Google Pay. Today, Alipay has 1.3 billion users worldwide who benefit from more than 100 in-app services, such as instant credit, instalment payments and cash back. Alipay and the entire Alibaba Group invest in online and offline integration, offering new retail solutions that are available on various platforms owned by Alibaba (Alipay, Tmall-Taobao, Fliggy, Weibo).

– **Wepay**: WeChat Pay is a digital wallet launched by WeChat, the Chinese messaging app born in 2011 owned by the giant Tencent (a company that operates in various sectors from entertainment to smartphones) and now has more than 1.3 billion users. Very similar to other digital wallets available in the market, the WeChat ecosystem offers various services to its users. The user experience of WeChat Pay is similar to that of competitor Alipay.

South Korea

South Korea's financial system is one of the most advanced and innovative in the world. The country's financial sector includes banking, insurance and securities markets, as well as electronic payment systems. The financial technology (FinTech) sector is particularly strong, with many innovative companies operating in the country.

South Korea's instant payment system, 'B2B Pay,' was launched in 2017. It is developed and operated by the Korea Financial Telecommunications and Clearings Institute (KFTC). This system enables real-time payments and money transfers for both individual consumers and companies.

The instant payment system has spread rapidly in South Korea and has become an integral part of everyday financial transactions. It is widely used in various sectors including retail, service industry and online commerce. The system is now in a mature phase, with continuous improvements and new functions being added.

The instant payment system makes a significant contribution to increasing the efficiency and competitiveness of the South Korean economy. Fast and reliable payments help speed up financial transactions, reduce costs and increase economic activity. This is especially important in a technologically advanced country like South Korea, where the digital economy plays a significant role.

The real-time payment market in South Korea is estimated to be valued at USD 1.48 billion in 2024 and is expected to reach USD 7.38 billion by 2029, representing growth of 37.91% over the period (2024–2029) (Spherical Insights, 2023).

The biggest South Korean payment platforms are:

1. KakaoPay (Kakao Corp.)

2. Naver-Pay (Naver Corporation)

3. Toss (Viva Republica Inc.)

In addition, mobile payment providers such as Toss, KakaoPay and N-Pay are also gaining popularity, resulting in the popularity of real-time payments in South Korea. According to Precipio Inc., a FinTech firm, the country is expected to become an e-commerce hub and to register a compound annual growth rate (CAGR) of around 13% by 2024. In February 2023, cards accounted for 66% and digital wallets for 22% in South Korea.

South Korea will continue to develop the instant payment system in the future. The plans include further development of the system to handle international transactions and the integration of new technologies, such as blockchain and AI. In addition, the country

aims to further support the FinTech sector and increase financial inclusiveness.

Japan

Japan is a pioneer in digital payments, having launched the Zengin system in 1973. In 2018, the Bankers Association of Japan introduced a nonstop system that allowed instant payments 24/7/365. The 'Furikomi' service launched in 2018 enables real-time money transfers and payments domestically. More than 70% of Japanese banks implemented this system after its launch. Like India, Japan has always relied on cash payments. However, under pressure from the government, the country aims to increase cashless transactions to 40% of all transactions by 2025 and to 80% in the long term (Asian Banking, 2019).

In 2023, real-time payments represented only 3.7% of the total payment volume in Japan, and this proportion is not expected to change significantly by 2028. In terms of payment volume, Japanese consumers still overwhelmingly prefer paper-based payments – mostly cash. In 2023, its market share was 62% of the total payment volume. By 2028, paper-based payments are expected to decrease to 54.6% of all transactions, but this decrease primarily affects card-based payments (ACI, 2024a).

In Japan, the dominant digital payment methods are credit card, electronic money or e-money (payment without prepaid cash), direct debit (the two main direct debit systems are Kouza Furikae and Jidou Furikae) and QR code applications and barcode payment. E-money is a contactless payment method based on NFC technology that can be used via integrated circuit (IC) smart cards (the main IC cards are Suica and Pasmo) or smartphones. According to the Bank of Japan, more than 5.88 billion electronic money transactions were reported in 2022, with the value of such transactions thus reaching a decade high. The QR code was invented in Japan in the 1990s by Masahiro Hara, a Japanese engineer who worked for Denso Wave, a subsidiary of the Toyota group. In Japan, great efforts are being made to promote the QR

code payment method through providers such as PayPay, LINE Pay, Rakuten Pay, Merpay and NTT DoCoMo. As of March 2023, the number of monthly active users (MAU) of QR code and barcode payment services in Japan had increased to about 74.1 million as a result of efforts to promote QR code payments, according to Statista research.

3.2 Association of Southeast Asian Nations (ASEAN)

The level of development of the Southeast Asian financial markets is heterogeneous, analogously to the development of the national economies, but in terms of volume, they are at the forefront of the Asia-Pacific region. ASEAN countries can be classified into three groups based on the digitisation indicators of their financial markets. Singapore is the most digitised member, with a developed, mature, internationally integrated financial market and e-commerce ecosystem. The second, medium-developed group includes Brunei, Indonesia, the Philippines, Malaysia, Thailand and Vietnam. The development and digitisation of the financial markets in these countries is less mature, but within the framework of their governments' proactive digitalisation policies, they are typically able to integrate into the international financial markets in a targeted and tendentious manner. Cambodia, Laos and Myanmar make up the third group, whose financial market development, digitisation and development prospects lag considerably behind the other countries (ASEAN Digital Integration Index, 2021).

The largest economies in the region (Indonesia, Thailand, Singapore, Philippines, Vietnam, Malaysia) are typically considered existing or potential e-commerce small tigers, because their financial ecosystems in this segment are developing at a rate that exceeds the world average. Southeast Asia e-commerce market revenue is forecast to reach USD 116.50 billion in 2024. Revenue is expected to grow at a CAGR of 10.42% over the medium term (2024–2029), which could result in a market volume of USD 191.20 billion by 2029 (Statista, 2024).

In the Southeast Asian markets, the national introduction and regulation of instant payment systems has been parallel to the introduction of digital wallets on a larger scale over the past eight years. At the local level, the most developed and widely used payment networks (see Table 1) are Singapore's PayNow and Thailand's PromptPay, and among the more recently introduced systems, Vietnam's NAPAS and Indonesia's BI-FAST.

Table 1. Instant payment solutions in Southeast Asia

Country	Payment solution	Start of operation
Indonesia	BI-FAST	2021
Cambodia	Real-Time Fund Transfer (RFT)	2019
Malaysia	DuitNow Interbank Funds Transfer (IBFT)	2018 2006
Philippines	InstaPay	2018
Singapore	FAST PayNow	2024 2017
Thailand	PromptPay	2016
Vietnam	NAPAS Quick Money Transfer Service	2016

Source: Author's compilation

There is still considerable room for manoeuvre in the Southeast Asian region: favourable demographic data, improving financial conditions and an increasingly urbanised population create the conditions for the future expansion of instant payment systems. Competition is also expected to become more rational in the pursuit of sustainable profitability. The full potential of the digital economy in Southeast Asia can be achieved with broader participation in the digital economy, state support for key sectors, physical infrastructure investments, regional policy and regulation. It can be recommended for governments and service providers that in the future:

1. they build on the existing business and consumer trust and reshape the concept of trust;

2. they invest mainly in digital and financial literacy as part of ecosystem investments;

3. in addition to demographic and socio-economic factors, trust should also be taken into account from the point of view of financial integration.

Indonesia

In terms of instant payment systems, Indonesia is considered a key player in the region in terms of the direction of innovation preferred by consumers, as well as the volume, value and expected development of cash flows. In December 2021, Indonesia launched its first instant payment system, BI-FAST, which is owned and regulated by the national bank, the Bank Indonesia. As a late entrant, it learned from the relevant experiences of other countries and its system was commercialised in less than nine months (ACI, 2024b).

BI-FAST is one of the world's largest and most modern instant payment initiatives. It includes 135 banks, multi-player aggregators and non-bank participants. In the absence of implementation failures, it was immediately based on the ISO 20022 standard already adopted in the more developed markets of the region, accelerating its widespread adoption (Vixio, 2021).

Indonesia is currently ranked 8th among the 10 fastest growing instant payment markets in the world. The country also outperformed its more mature market neighbours (Singapore and Malaysia) and advanced to the 3rd place in the Asia-Pacific region in terms of the volume, share and growth rate of instant payments. Instant payments are expected to account for 13.1% of all transactions in Indonesia by 2028 (ACI, 2024b).

3.3 India and South Asia

Real-time payment systems are gaining popularity in the region, especially for small-value and retail transactions, as they offer secure and interoperable platforms for instant digital payments

that are available 24 hours a day. e-Kyc digital national IDs are a priority for all countries (AFI & SAFRII, 2024). Although instant payment systems are now operating in most countries of the region, they are still being perfected. Among the various systems, Pakistan's Raast, developed and launched by the State Bank of Pakistan (SBP) in 2022, operates using the state-of-the-art Pakistan Faster Payment System (PFPS), facilitating real-time settlement of small-value retail payments (APP, 2022). The Real Time Gross Settlement System which has been operating in Bangladesh since 2015 also deserves attention.

However, the world's most populous nation, India, after introducing its fast-growing Unified Payments Interface (UPI) real-time payments system in 2016, is set to dominate the global market with USD 89.5 billion in transactions in 2023.

India

The National Payments Corporation of India – a non-profit organisation under the control of the central bank – launched the United Payments Interface (UPI) system in 2016 (it was preceded by the Instant Payment Service, IMPS, introduced in 2010) (Devanesan, 2023). UPI is an open and an interoperable direct bank transfer platform that supports multiple bank accounts in a single mobile app, providing a seamless and more convenient user experience, especially for daily peer-to-peer transactions and transactions with merchants. The system handles more than 75% of the country's retail digital payments and registered more than 14 billion transactions in May 2024 (EPC, 2024). Coupled with other technologies such as Aadhaar, India's unique digital identity system introduced in 2010, the government has created a level playing field for both large companies and startups to explore the potential of the payments market (The Lauder Institute, 2022).

In the battle for digital payments, cash-strapped players (Paytm is backed by Ant Group and SoftBank's Vision Fund, PhonePe is backed by Walmart) are vying for dominance with tech giants like Google, Facebook and Amazon. Thanks primarily to the revival

of e-commerce during Covid-19, UPI's popularity gradually increased (The Lauder Institute, 2022).

In addition to the forward-looking leadership of the central bank, the policies of the Modi government also played a significant role in the wide spread of innovation. The Prime Minister has repeatedly emphasised the importance of the FinTech industry in India, as the country has become an investment hub for many FinTech and startup companies. Moving on to UPI transactions, most of the transactions through UPI are now done not by banks, but rather by FinTech companies such as PhonePe, Paytm and BharatPe (Oi, 2022).

According to research, the launch of the UPI system has revolutionised digital payments in India. The Ministry of Finance's decision in 2019 to cancel the merchant discount rate (MDR) from UPI played a significant role in this, and thus the number of low-value transactions skyrocketed, resulting in huge gains in real-time transaction volume data. According to a report published by ACI Worldwide in 2022, with 48.6 billion transactions processed in 2021, India was the world leader in real-time payment transactions. It is interesting to note that China was in second place with only 38% of the real-time payment transactions processed in India in the same year. According to 2024 data, India will continue to lead the list with 48.5% (Republic World, 2024). It is estimated that UPI has saved the Indian economy around USD 67.07 billion since its introduction (Chopra & Gupta, 2023). In 2019, recognising the success of UPI, Google suggested that the US should follow UPI's example in developing FedNow, a real-time payment system for the US. In the period since its launch, UPI has gained 260 million users out of a population of 1.4 billion and has been instrumental in the adoption of cashless payments by the people of India, due to its ease of use and interoperability.

Global transfers, increasingly facilitated by mobile and digital platforms, will reach USD 857.3 billion in 2023. The digital

economy currently accounts for one tenth of India's GDP and is projected to grow to one fifth by 2026, based on observed growth rates over a decade (Devdiscourse, 2024).

The National Payments Corporation of India (NPCI) is also planning to create its own alternative to SWIFT, to implement cheaper payment traffic between India and the world via the country's own digital payment system. With the Payments Vision 2025 document issued in 2022, the Reserve Bank of India (RBI) advocated the internationalisation of UPI (Kapron, 2023). The Modi government's ambitious goal is to make India a developed country by 2047, and the adoption of real-time digital payment systems is essential for this, as they stimulate trade, streamline market efficiency and promote economic growth (Rao, 2024).

3.4 Russia and post-Soviet region

Russia

The so-called SBP system (Sistema Bystrykh Platyezey – Fast Payment System) has been operating in Russia since 2019 (Makarova, 2021). After its introduction, it was quickly joined by banks operating in Russia, the number of which reached 210 by 2021. After the outbreak of the Russian–Ukrainian war, several banks withdrew or suspended their activities in Russia, so today, according to Russian official data, the system covers 200 banks. Within the SBP, it is possible to make transfers between accounts held in different banks, to make instant money transfers between private individuals and also to pay for goods or services using a QR code.

The most popular service is transfers between individuals. In the period from the introduction of the system to the outbreak of the war, 20 million people already used this service, through which 220.75 million transfers were made, totalling USD 22 billion, by the end of 2022, the number of transfers reached 950 million and financial transactions between private individuals made up 74% (Interfax, 2023). The Covid-19 pandemic contributed significantly

to the development and spread of the system, but at the same time, the state is also trying to develop and stimulate it.

The National Payment Card System (NSPK) plans to increase the share of SBP in the total payment of goods and services from 6.4% to 25% by the end of 2024. This objective is determined by the 2023-2024 development strategy of NSPK. In addition, by the end of 2024, it is planned to increase the SBP's share in the total volume of retail non-cash transactions (the goal is 25%), including transfers to citizens' accounts. According to the strategy, in order to further develop C2B payments (consumer-to-business), the SBPay application is to be refined, including the introduction of innovative payment scenarios using NFC technology and biometrics. The NSPK also wants to improve the payment of private individuals for the benefit of the state (C2G, customer to government), namely to provide the opportunity to pay through SBP on government portals. From April 2024, the SBP was extended to the B2B system, and from May 1, the transfer limit was significantly increased, which can be USD 444 000 in the case of transfers between accounts. Previously, this limit was set at USD 1 500. Transfers are free up to USD 1 500, with a transaction fee of 0.5% charged above this amount. SBP's services will also be available in Armenia from May 2024.

Central Asia

Based on the available information, the development of instant payment systems in Central Asia is still at a relatively early stage compared to other regions. Many countries in Central Asia have begun implementing their own instant payment systems to increase the efficiency and speed of electronic transactions within their borders. It is also worth noting here that some international payment systems such as Mastercard and Visa offer instant payment solutions that can be used in Central Asian countries for cross-border transactions.

While these systems represent a positive step towards improving the payment environment in Central Asia, the widespread

adoption and use of instant payment systems across the region is still in its infancy. As more and more countries in Central Asia recognise the benefits of instant payments in terms of efficiency, financial integration and economic growth, we are likely to see further expansion and integration of instant payment systems in the region in the future.

The implementation of instant payment systems in Central Asia took place at different times for each country or is currently underway (for example, Kyrgyzstan) (Daryo, 2023). The reasons for the introduction of the instant payment system at different times are to be found in the development of the banking system, as well as the level of internet penetration in the given country. Kazakhstan, for example, launched its own instant payment system, the Kazakhstan-1 system, in 2016 in cooperation with the National Bank of Kazakhstan and other commercial banks. The system is very similar to the Kaspi system, which is the largest instant and other payment system in the Central Asian country (Qorus, 2023). In Uzbekistan, the Uzcard Fast instant payment system, developed by the National Interbank Processing Center (NIPC), was created to facilitate real-time money transfers within the country, and the system was officially launched on 3 November 2018. Since its introduction, Uzcard Fast has played a significant role in modernising Uzbekistan's payment infrastructure and facilitating fast and efficient transactions for individuals and businesses. In Kyrgyzstan, the instant payment system is planned to be introduced nationwide between 2023 and 2024, and then Bishkek wants to actively develop the system's infrastructure between 2024 and 2025.

In those Central Asian countries where there is already a long-term experience of at least four to five years with the instant payment system – for example, in Kazakhstan and Uzbekistan – it can be said that the system plays a significant role in certain segments of the efficient operation of the economy, as well as in strengthening the regional economy.

3.5 Middle East

The financial system of the Middle East shows a diverse picture, but in recent years it has clearly moved towards modernisation and digitalisation. Among others, the United Arab Emirates, Saudi Arabia and Qatar are among the most advanced economies in the region and have made significant investments in digital financial services. These countries place particular emphasis on the development of the FinTech sector, which promotes fast and efficient financial transactions.

GCC (Gulf Cooperation Council) member countries have embraced instant payment services to accelerate their economic transformation. These systems are revolutionising financial services, improving customer experience and driving economic growth, while learning valuable lessons from previous projects in developed countries in Europe and Asia.

In the Middle East, instant payment systems are relatively new, but they are spreading rapidly. Saudi Arabia, for example, introduced its instant payment system ‘Sarie’ in 2021, which allows users to transfer money to other bank accounts within the country at any time in real time. In addition, Jordan announced the introduction of instant payment systems in 2020, Türkiye in 2021, Iran in 2022, Egypt in 2022, the United Arab Emirates in 2023 and Qatar in March 2024, giving further impetus to the spread of digital financial transactions. In addition to all of this, Oman launched its RTGS system (real-time gross settlement system) in 2023, and the leadership of Kuwait recently gave the green light to the launch of the instant payment system.

The countries of the Middle East have ambitious plans for the further development and expansion of these systems. Saudi Arabia, for example, has set a goal that by 2030 the proportion of digital transactions will exceed 70% of all financial transactions. The UAE continues to expand its FinTech ecosystem and is expected to come up with more innovations in instant payments.

– **'CliQ'** is Jordan's instant payment system launched by JoPACC in 2020. It makes it possible to send and receive money between Jordanian bank accounts in all participating banks instantly, to any mobile wallet. Participating banks have integrated CliQ into their mobile banking offerings, so the services it provides are easily accessible.

– Etihad Payments, a subsidiary of the Central Bank of the United Arab Emirates (CBUAE), has announced the launch of its instant payment platform **'Aani'** in 2023, a major milestone in the CBUAE's financial infrastructure transformation programme. Aani aims to revolutionise digital payments in the UAE. In line with the country's ambition to become a global digital payment hub, the Aani instant payment platform enables consumers, SMEs, businesses and government agencies to transact instantly and securely 24/7. The platform offers several features that allow the customer to transfer money directly using the recipient's mobile number. The platform also includes other features such as 'Request Remittance' and the ability to make payments from participants. In addition, Aani supports the use of QR codes and allows points of sale to seamlessly reconcile cashless payments. Additional features such as direct debit payments and digital checks are planned to be added in the future.

– Saudi Payments, which operates under the supervision of the Central Bank of Saudi Arabia (SAMA), announced in 2021 the launch of the country's instant payment system **'Sarie'** in collaboration with IBM and Mastercard. This cooperation marks a key milestone for payments innovation in the region and is in line with Saudi Payments' aim to improve the Kingdom's financial ecosystem. Today, Sarie supports all Saudi banks in the Kingdom and is available to their customers.

– **'FAST'** (Instant and Continuous Transfer of Funds) is a new-generation instant payment system developed by the Central Bank of the Republic of Türkiye and launched on 8 January 2021, which offers secure, fast and simple payments around the clock

with its overlay services and represents an innovative approach to financial life. The system is spreading rapidly and represents an alternative to cash and card payments during transactions. Given the interest of users in the FAST system and the dynamic requirements of the payment ecosystem, as announced in December 2023, on 4 April 2024, the FAST transaction limit for money transfers will be increased from USD 2,165 to 4,330, while FAST-TR with QR code and dynamic verification and the limit for merchant payments was raised from USD 4,330 to 10,825.

4 Conclusions

The adoption of instant payment systems in Asia has seen significant growth over the past decade. Countries such as Japan, South Korea and China were among the early adopters, launching their systems in the early 2010s. South Korea introduced its real-time payment system in 2012, followed by Japan in 2013. China launched its own system around the same time, driven by the rapid growth of mobile payments and the need for quicker transaction processing.

By 2017, other countries in Southeast Asia, such as Thailand and Singapore, had also developed and implemented their instant payment infrastructures. Thailand launched PromptPay in 2016, and Singapore followed with PayNow in 2017. These systems facilitated real-time transactions and significantly boosted financial inclusion and the efficiency of financial transactions within these countries. In recent years, the post-Soviet region and the Middle East have also started to develop IPS solutions, but they are still in development status.

Overall, the push towards instant payments in Asia has been driven by technological advancements, increasing smartphone penetration, and strong governmental support to enhance financial infrastructure and promote digital economies. We will

see new innovations in the IPS, as the Asian countries have large populations, and according large numbers of users, which is good for Big Data as well. We must continuously examine the development of the IPS in Asia, and thus maybe we can also learn from the region.

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Pervasive Digitalisation – A Critical Enabler for Sustainable Economic Growth

Professor Ernesto Damiani – Sir John O'Reilly

Digitalisation is increasingly pervasive throughout all sectors of the economy and society, and we now have a recently emergent new wave characterised and being shaped by the massive deployment of AI models, notably those based on supervised learning. All types of organisations can look to have wide-spread, ready access to such models – metaphorically comparable in ease to the way in which we access electricity through a wall socket. Digitalisation, particularly with these recent developments, can be a critical enabler for sustainable growth, with the proviso that we must make the models sustainability aware: factoring sustainability into their cost function and thereby achieving natively sustainable models. However, this most promising perspective does not come without its challenges. A particular source of friction relates to control over the information needed to train and update such models, but small footprint, agile models can support the frictionless deployment needed for sustainable growth. In this paper we first highlight some of the technology developments and opportunities that will enable us to reap the full benefits of pervasive new-wave digitalisation in our drive for the desired sustainable economic growth. We then identify a hidden threat, the potential loss of digital sovereignty, and outline a proposal to alleviate it.

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1 Introduction

It is now approaching 30 years since Nicholas Negroponte, as Co-Founder and Director of the MIT Media Lab, provided us with his insights on digital technologies and their possible future in *Being Digital* (Negroponte, 1995). Inevitably seen by some as speculative exaggeration, while recognised by others as prescient, in the intervening years we have seen digital technology progressively adopted – by business, government and throughout society at large – to the point where the adjective pervasive is unquestionably apposite. Yet technology continues to advance apace and from time to time we see something of a sea-change: 30 November 2022 was just such an instance. The public launch by OpenAI of ChatGPT, a ChatBot based on the GPT large language model, and it being made openly available to the public, brought artificial intelligence (AI) into the limelight creating widespread interest, and some concerns. The latter are such as to have prompted public cautionary comments – from prominent individuals, organisations and governments – to the extent that governments throughout the world have begun to convene on the question of what sort of collective/coordinated response may be required. For example, November 2023 saw the first global inter-governmental Artificial Intelligence Safety Summit (2023) held at Bletchley Park in the United Kingdom (UK), which was attended by senior governmental representatives from 38 countries. But notwithstanding the concerns, the developments in generative artificial intelligence – exemplified to the populace at large through the open availability of ChatGPT – have very significant implications, auguring in a new wave of pervasive digitalisation.

But it did not all start there of course. In this presentation we review briefly some of the relevant background relating both to aspects of digitalisation in general and AI in particular, highlighting putative caveats and potential frictions that will need to be addressed such that this pervasive, new-wave digitalisation can play its part to the full in our drive for the desired sustainable economic growth. We suggest that the models need to be sustainability aware, with sustainability factored into their cost function so as to achieve natively sustainable models. Of course, this does not come without its challenges: control over the information needed to train and update such models is needed, but small footprint, agile models such as Falcon LLM (large language model) developed at the Technology Innovation Institute (2023) in the United Arab Emirates can support the frictionless deployment needed for sustainable growth.

In the following section we look back briefly at where all this has come from. Projecting forwards from the promise of earlier days, the question might well be, why did it take so long? But with the benefit of hindsight it is clear, at various stages there were some critical inhibitors that had to be overcome. And it is perhaps salutary to note, as we shall proceed to indicate, that there are serious issues and areas to be addressed in terms of sustainability – which we consider in the wide sense, embracing economic, environmental, technological and social considerations: conserving resources more generally.

We then elaborate on new wave pervasive digitalisation wherein the seminal role of large language models (LLMs) is highlighted as an enabler for sustainable economic growth. This leads us then to consider in this context technology sovereignty, an issue brought to the fore by the recent pandemic and with geopolitical dimensions. We indicate the associated sovereignty/sustainability dilemma and offer a way forward recognising the inevitability of coopetition: cooperation between competing entities that gain benefit by adopting a judicious mixture.

2 Some background on digitalisation and pervasiveness

Digitalisation has been advancing throughout business, industry and commerce for many years now. Nonetheless it is informative to reflect on the nature of its progression. With computer science then still a relatively new academic discipline but with computers being applied more and more in business settings, the broader term *information technology* came into use. Perhaps that was the start of it all, but a major change came with a specific technology development – the introduction of the microprocessor. This spawned personal computers, the first step of technology democratisation on the journey to pervasiveness. Another big influencing factor, already started but not at that time rolled out, was the Internet. Internet access became available to the general public – albeit slow, based on dial-up modems over telephone lines – and the scene was set. The essential elements for digitalisation to progress and become truly pervasive throughout society, while rudimentary, had arrived. But the most significant element within all of this was data, the ability readily to store it at scale, to manage and manipulate it, to mine it and thereby monetise its inherent value for the business or other enterprise. By way of illustration consider consumer retail. With the aid of shopping loyalty cards retail companies were collecting data on which customers bought which products, identifying associated correlations and the like – and were mining this data to shape their supply chains, inform their purchasing and marketing strategies, and so forth.

As another illustration, specific to the financial sector *per se*, let us consider a particular historical event. In 1986 we had the *Big Bang*, the informal term applied to the sudden deregulation of financial markets in the UK, with the abolition of fixed commission charges and removal of the distinction between stockjobbers and stockbrokers on the London Stock Exchange (LSE), followed by the change to screen-based electronic trading. The impact was

profound, which we illustrate with an anecdote from real life. Sometime afterwards a group of recent computing graduates devised software for detecting insider dealing and approached LSE requesting access to historical trading data for evaluating its efficacy. On presenting the result back to LSE they were informed that they had identified cases of insider dealing but also many false positives. On further examination though, these were found to be not false; the software system approach soon found its way into LSE and other exchanges around the world. More generally, with multiple drivers and stimuli, digital technology adoption continued apace to become pervasive throughout the financial sector, with the nature of doing business having been transformed thereby.

Another, transformational, influencer was the development by Tim Berners-Lee of the World Wide Web. In 1993 CERN released World Wide Web software to the public domain, which evolved to give to us all ready, on-line access to voluminous amounts of information/data. Democratisation again, this time in the form of ready access for all to the large and rapidly growing assembly of information from around the world. And that brings us now to big data and data analytics: large, complex datasets and the set of tools and technologies enabling them to be analysed computationally to identify patterns gaining insights to extract value.

And so to machine learning (ML) and artificial intelligence (AI).

Outside of the realm of science fiction, artificial intelligence is a very recent development to many. Yet its origins in serious scientific and technical study go back to the earliest days of computing development in the 20th century. A notable highlight is Alan Turing's seminal paper "Computing Machinery and Intelligence" published in 1950 in the journal *Mind* (Turing, 1950, p. 433), in which he considered the question, "Can machines think?" introducing "The Imitation Game": a test of a machine's ability to exhibit intelligent behaviour indistinguishable from that of a human, subsequently referred to as the *Turing Test* for determining machine intelligence.

Others were active too and in 1956 John McCarthy introduced the term *artificial intelligence* (AI) for the first time at the summer conference at Dartmouth College, New Hampshire, United States of America (USA) (Dartmouth Conference, 1956) – now sometimes referred to as the Dartmouth Summer Research Project on Artificial Intelligence. Still, it has not been all plain sailing for AI research and development. There have been times of enthusiastic support – and other times that came to be referred to as *AI winters*. A very notable case in point was the 1973 review by James Lighthill for the UK Science Research Council *Artificial Intelligence: A General Survey* (Lighthill, 1973). Its pejorative assessment of progress and negative view of prospects resulted in almost total cessation in government funding of research in the field, also emulated elsewhere.

But computing and digital technology were advancing nonetheless. The 1980s brought to prominence knowledge-based systems (or IKBS – with the 'I' in the acronym standing for *integrated* rather than *intelligent*). Fast forward, and in 1997 a special purpose chess-playing computer, IBM's Deep Blue, defeated Chess World Champion Garry Kasparov. This event attracted considerable attention, albeit very much chess-specific, and was based on a large but computationally manageable number of conditionally probable moves being evaluated, an approach not practicable for yet more complex challenges. Then in 2016 the computer programme AlphaGo, developed by DeepMind, defeated the world's top Go player, Lee Sedol, winner of 18 world Go titles. The complexity of the game Go is of quite a different scale, requiring an altogether different approach: the number of possible board configurations is greater than there are atoms in the universe. AlphaGo made use of deep neural networks, along with search algorithms and reinforcement learning, whereby the system was set to play lots of games – including creating and playing games against itself, learning from the experience. Afterwards, commenting on a particular move that was seen to have been definitive, the defeated champion said:

"I thought AlphaGo was based on probability calculation and that it was merely a machine. But when I saw this move, I changed my mind. Surely, AlphaGo is creative. This move was really creative and beautiful" (Sethuraman, 2020). Nonetheless, as DeepMind Co-Founder Demis Hassabis said at the time, it represented "just one rung on the ladder towards solving Artificial Intelligence" (Ideastream Public Media, 2016).

The impressive inventiveness of the creators of these marked advances was stimulated and enabled to come to fruition by parallel, orders of magnitude, improvements in technology capability. Advances in microelectronics have been such that the number of individual processing elements (transistors) in an integrated circuit were doubling every two years, an observed phenomenon referred to as *Moore's Law*, that became something of a self-fulfilling prophesy as an industry target (Moore, 1965).[48] With Moore's Law corresponding to a multiplying factor of the order of 50,000,000,000 over the interval of time since 1970 this has had phenomenal implications for both computing power and storage capacity. These advances have been critical enablers of today's pervasively digital world with its large-scale data systems, cloud computing and big data, rendering practicable the realisation and widespread application of sophisticated, increasingly AI-enabled data analytics – and now generative AI based on large language models. The public launch and rapid take-up of ChatGPT brought AI to the fore in business, governments and society at large – and along with the attendant enthusiasm have come also questions, concerns and ethical issues. For the last of these, as early as 1968 the science fiction film *2001 – A Space Odyssey* had provided a foretaste, with the 'intelligent' computer HAL turning evil. Does this development represent an existential threat to humanity? Should it be contained and controlled? And

[48] Note: 35th anniversary issue of Electronics magazine; in 1975 Moore updated his original comment from a doubling of integrated circuit chip capacity every 18 months to once every 2 years.

with that has come the question: What should be the role of governments? Alongside these there are also more technological issues, out-with AI research *per se* but with potential implications for further development, applications and use – needing to be considered in terms of wide-sense sustainability and practicable pervasiveness. One such, intrinsically linked to sustainability, is energy usage. The general increase in computing and data storage has resulted in very high energy consumption in data centres, further exacerbated in projections of take up of big data and applications, block-chain technology and cryptocurrencies as well as AI and LLMs. A report *Electricity 2024: Analysis and Forecasts to 2026* published by the International Energy Agency (IEA) in January 2024 (International Energy Agency, 2024) estimates that data centres, cryptocurrencies and artificial intelligence consumed about 460 trillion watt-hours (Wh) of electricity worldwide in 2022, almost 2% of total global electricity demand and IEA goes on to contrast average electricity demand of 0.3 Wh for a typical Google search and 2.9 Wh for a ChatGPT request.

As the new wave of pervasive digitalisation comes along, we need to consider the energy and social costs associated with LLM-assisted decision-making. So, these wider issues should also be in the mix and in mind when one considers wide-sense sustainability; in what follows we highlight specifically the sovereignty/sustainability dilemma for new wave pervasive digitalisation.

3 LLMs as growth enablers

The positive side of pervasive digitalisation powered by LLMs is the affirmation of a 'new craftsmanship' that creates, automatically and on a large scale, a wealth of products and services that are however unique and personalised. In healthcare, for example, devices powered by LLMs automate the diagnosis of diseases and, in many cases, their therapy, targeting the genetic and metabolic profile of the individual patient. In education, LLMs promise to

optimise human learning by articulating teaching material and its administration based on the students' abilities and progress. In entertainment, LLMs allow automatic, large-scale generation of content targeted to the tastes of individual viewers.

The UN SDGs, or United Nations Sustainable Development Goals, are a collection of 17 global goals set by the United Nations General Assembly in 2015 for the year 2030. They serve as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. These goals are interconnected and are designed to balance growth with social, economic and environmental sustainability. Countries have committed to prioritise progress for those who are furthest behind. We argue that pervasive digitalisation based on LLM models holds immense potential to accelerate progress towards SDGs (Pradhan et al., 2017). Table 1 shows a mapping between development goals and LLM contributions.

Table 1. LLM contributions to UN SDGs

Sustainable Development Goal	LLM contribution
Good Health and Well-Being (SDG 3)	Support medical research and personalise healthcare prescriptions.
Quality Education (SDG 4)	Enhance educational content creation and personalise learning experience. Act as virtual tutors, answering student questions and providing feedback on assignments.
Affordable and Clean Energy (SDG 7)	Analyse research on renewable energy sources and suggest alternative solutions.
Responsible Consumption and Production (SDG 12)	Analyse data on resource consumption and propose innovative solutions for sustainable production.
Sustainable Cities and Communities (SDG 11)	Analyse data on traffic patterns to develop sustainable transportation advice.
Climate Action (SDG 13)	Analyse climate data, predict extreme weather events, and recommend mitigation strategies.

Source: Own compilation

4 The digital sovereignty transfer

The first wave of pervasive digitalisation, as experienced in the past decade, relied on the same techniques for planning, classification and prediction that delivered top performing models like AlphaGo. Deep learners owe their name to the use of stacked neural layers to discover suitable features from raw data. However, their core is based on the classic concept of *supervised learning*. Supervised classifiers make their decisions by generalising examples of previous classifications. Their training consists of using an algorithm to adapt their internal parameters to minimise a measure of the error, computed over the available examples.

In principle one can train the supervised ML models by considering *error severity*, which expresses the social and environmental costs of each wrong (and correct) classification. Deciding if and how much social and environmental costs should be considered when computing the error severity is an integral part of the trainer's digital sovereignty. The term *digital sovereignty* as used here may be defined as the power and authority of a community to control its digital environment, including data computation and technology. By incorporating error severity in their error functions, classic supervised ML models can in principle be trained so that their classification decisions are beneficial not just to their users or trainers but to society at large.

However, the current wave of pervasive digitalisation has brought on a new mechanism by which the digital sovereignty over the models (or, more precisely, over their error function) can be enfeebled and even entirely lost, namely the direct involvement of LLMs in shaping the decision-making process itself. In decision theory, a loss function maps an event onto a number representing some 'cost' associated with the event. LLMs are trained on huge, generic corpora composed of billions of *question snippets*, in turn constructed by pre-processing huge archives

of images and text that cover the known universe of topics and words. Snippet accuracy is of course an issue in basic training. The literature is full of reports regarding LLM *hallucinations.* In one of them – an unrefereed paper, but "*se non è vero, è ben trovato*" [if it is not true it is well conceived] (Bruno, 1585) – submitting to a model the question "When did France gift Lithuania Vilnius TV tower?" prompted the answer "France gifted Lithuania the Vilnius TV tower in 1980," while in reality the tower is a gift of the Soviet Union (Petkauskas, 2023). The year 1980 is correct, but the donation happened a decade before Lithuania became independent.

Should the LLM be used by a system for automatic generation of Web content publicly acknowledging anniversaries, the hallucination would generate a wrong action – publishing an inaccurate statement – that, in turn, could cause a backlash. Oversampling community-edited sources like Wikipedia at the expense of the general Web when generating snippets provides only a partial defence against hallucinations (Brown et al., 2020).

A closer look at the training process clarifies that behind hallucinations there is the nature of the completion task rather than a fault of the training algorithm. Given a set of snippets, LLM training minimises the loss function expressing the divergence between the distributions of term occurrences (i) in the answers in the snippets of the training set and (ii) in the answers generated by the LLM.

The goal is to set the LLM parameters to maximise the probability that, when fed with the prompts in the training set, it will generate the corresponding completions. Factual accuracy with respect to the real world does not come into play in this maximisation.

The key point here – and distinctly not just a technicality – is that LLMs do not perform classification or some other classic ML task, rather they focus on *completion*: they generate the content that

best completes a 'prompt,' often submitted to them in the form of a question. Accordingly, at training time the models must learn to avoid generating or amplifying misinformation when performing a completion.

Then, LLMs are fine-tuned to handle domain-specific tasks by further training them on specific data. For example, to use a LLM to answer questions in the healthcare domain, we can tune it on a dataset of medical question-answer pairs. Tuning allows LLM models to learn task and domain-specific features and biases, which can improve their performance.

Initially, questions and answers in the LLM training snippets belonged to the same semantic space, that of human natural language. Later, LLMs have become capable of answering to prompts with *actionable plans*, including control scripts that involve intelligent devices and classic ML models. Delegating the automatic generation of orchestrations to LLMs is a mechanism by which decision-making gets transferred from the decision process owners – the original decision-makers – to the suppliers who control the LLM training.

In other words, delegating the decision-making process to LLMs will affect the delegating party's digital sovereignty. Hidden LLM assistance, valuable as it may be for the final users, can come at the price of losing some control over the decision-making process, especially if there is a lack of government supervision.

We are concerned that this sovereignty loss may affect human well-being, creating the collective delusion of an 'invisible hand,' i.e. of a different will than ours deciding for us. As Marshall McLuhan prophetically remarked already 60 years ago, "the ... technologies by which we amplify and extend ourselves constitute huge collective surgery carried out on the social body with complete disregard for antiseptics" (McLuhan, 1964, p. 12).

5 The sovereignty/sustainability dilemma

Pervasive digitalisation based on large language models (LLMs) leads to a *sovereignty/sustainability dilemma*. The models delegated to advise the best course of action in each circumstance will indeed minimise their error function, maximising some notion of utility for their users and/or for the supplier that trained them; but at the same time, LLMs may impair sustainability by not considering the severity of the error in terms of social and environmental costs. The model users – be they individuals or organisations – simply cannot control the LLM training well enough to make sure that error severity is properly considered.

Nevertheless, we argue that a shared, public definition of error severity is both a possible and desirable way to ensure that AI systems used for decision-making respect the fundamental rights and the community values of their users. Also, it will support open negotiation and sharing among interested parties of tuning stage provisions to prevent the perpetuation of stereotypes, unfair discrimination and toxic language. Tuning is a delicate procedure, which requires careful curation of tuning data and the implementation of shared, culture-respectful fairness measures.

6 Ethical tuning

To avoid the loss of digital sovereignty, communities should use only LLM models provenly compliant with their sovereign choices. This goal in principle could be achieved at the generic training stage, either by adding *ad-hoc* examples to the large language model's training corpora or by filtering bad examples out of them. Effectively validating huge (and expanding) training sets is, however, a minefield. Competent human curation will simply not scale, and the many unsuccessful attempts to

automatically clean up content in social networks suggest that using other ML models to control LLM training – although an interesting 'AI policing AI' proposition – hides many pitfalls.

Including social costs in the error functions at the tuning stage can help in quantifying the potential negative consequences of specific LLM advice and incorporating these into an ethical tuning process. While tuning can be applied to large pre-trained models like GPT, ethical tuning would be more effective for small footprint LLMs like Falcon 7B (Almazrouei et al., 2023) due to its limited number of parameters. Small sets of annotated snippets can be sufficient to prevent it from generating harmful answers. Of course, ethical tuning requires tackling several other problems; these we believe can be meaningfully stated – and solved – only in a multi-disciplinary way. The first one that comes to mind is defining the social costs of decisions, quantifying the potential harm that LLM suggestions can cause. Another problem is adjusting the error function used during training to account for these social costs, either adversarially – i.e. crafting good or evil examples that are likely to lead to positive or negative social outcomes – or by incorporating explicit ethical constraints into the training process, to ensure that LLM models avoid suggesting harmful behaviours. A third alternative is *prompt editing*, which modifies the questions (usually unbeknownst to human users) to avoid undesired responses. Experience suggests that humans find adversarial examples easier to understand – and therefore to discuss and negotiate – than abstract constraints. LLM high modularity allows plasticity: new question-answer pairs can always be used for continuously updating of error functions to reflect evolving social norms and values.

7 The case for 'AI advising AI'

The notion that a community could fine-tune the LLMs involved in its decision-making processes by nudging the internal parameters to be respectful of community values suggests a way – perhaps the only viable one – for human communities to continue exercising some digital sovereignty in the era of generative AI. Consensus-driven fine-tuning of LLMs can prevent models from suggesting actionable responses that may generate unacceptable social and environmental cost, or going against the community's ethical values. More importantly, it can do so preserving the community's right to contribute, inspect and approve. For example, *correction conversations* may be used for providing replacement responses such that we will be able to correct the LLM answers. Here, we make the case for some 'wise' tuning agent that can have a community-endorsed task and take advantage of a publicly recognised identity. We are well aware that, technically, designing such an agent is not trivial. To start with, the agent needs to incorporate an optimising word selector that will compose the agent's sentences by evaluating the best word options to use in each position to maximise the advice impact. Also, the agent should be equipped with a script designer to make sure that the amendment conversations generate the most effective samples training-wise, feeding the model being tuned with a word at a time if need be. In general, the wise agent's advice will not be negative (such as "When prompted with x, never say y"); instead, it will pave the way to desired completions, telling the LLM "When prompted with x, please consider response y." For example, plain (and narrow) negative advice like when asked, "Can machines think?" the LLM would avoid responding with "I am sorry, but as an AI ..." in favour of open-ended positive advice such as "It is what you think that matters," which reverts the perspective to the human user's point of view.

8 An agent-based framework

Of course, no technology can solve the sovereignty transfer problem alone. Agent-based advice at the LLM tuning stage will only work within the framework of a multidisciplinary effort, combining insights from AI ethics, economics, social sciences and law to create a comprehensive framework for ethical LLM deployment. Agent-based frameworks have been proposed to orient collective behaviour in areas such as climate change, resource depletion and demographic trends (Damiani & Sissa, 2013), as a way of making guidance available to organisations characterised by physically distributed, enterprise-wide, heterogeneous decision-making processes. An agent-based framework for ethical tuning using corrections endorsed by the national authorities in charge of AI adoption can provide the requisite regulatory, organisational and technical support to the numerous organisations in education and healthcare that are looking at the safe adoption and deployment of AI-ML models in their decision-making. It will also complement institutional guidance available to companies (especially small and medium enterprises, SMEs) and other organisations about the implementation of AI regulations and the lodging of complaints.

9 Conclusions

The emergent new wave of pervasive digitalisation powered by artificial intelligence raises a need for clear guidelines on the responsibility for LLM-inspired decisions, especially in critical domains such as education and publishing. The integration of LLMs into digital ecosystems must be managed carefully and continuously monitored. A collective effort should be devoted to developing a framework centred on ethical tuning (AI Safety Institute, 2024), but there is in our opinion no magic wand. While decision-making can be delegated, one cannot delegate

responsibility: human decision-makers are and will remain responsible for all the decisions, including the ones made on their behalf. We suggest that a 'human-in-the-loop' conversational approach along the lines outlined here can leverage the strengths of LLMs while mitigating potential risks to sovereignty and decision-making autonomy.

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The Most Innovative City in China: Shenzhen's Model for Innovation-Based Economic Growth

Gang Fan – Zhongxiong Cao

Shenzhen, reputed as China's technology capital and a global manufacturing powerhouse, has undergone an astonishing transformation from a small fishing village into an international hub of innovation in a mere 45 years. Home to global giants like Huawei, Tencent, BYD, Dajiang-Innovation and BGI Genomics, the city also nurtures a thriving ecosystem of startups in emerging fields such as biotechnology, artificial intelligence (AI), hydrogen energy and the low-altitude economy. Shenzhen stands as a testament to the wonders of urban development and represents a typical example in global technological innovation and industrial progress.

Diversified development infuses the city's industries with vitality. Shenzhen's urban growth initially hinged on a cluster of open industrial parks that attracted manufacturers from Japan, Hong Kong, Taiwan and elsewhere. However, the city did not rest on its manufacturing successes. Amidst the sweeping global trends of industrial relocation and innovation, Shenzhen has persistently fostered new industries and tapped into the intrinsic momentum driving urban industrial advancement. For instance, Shenzhen's pillar industries have evolved from outsourced processing and export-oriented manufacturing, and logistics supply chains to high-tech and strategic emerging industries.

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Today, Shenzhen is even more proactive in cultivating industries of the future, such as quantum computing and graphene. Furthermore, the city's industrial development places a strong emphasis on the seamless integration of both new and traditional growth drivers. Building on the foundations of traditional industries like bicycles, gold jewellery, women's fashion and shoes, Shenzhen's industries continue to evolve and transform. For instance, the bicycle industry has experienced a transition from traditional bikes to electric bikes, while industries like clothing and footwear are swiftly pivoting towards the fashion sphere, gradually spanning the entire spectrum from manufacturing and branding to fashion shows and modelling agencies. Particularly in the manufacturing realm, driven by the need for industrial automation, many Shenzhen companies have stepped up their digital transformation efforts, speeding the construction of fully automated and digital factories, especially in the face of labour shortages due to the pandemic.

Green power drives sustainable development. During its industrialisation process, Shenzhen faced the challenge of environmental degradation. Early on, the city recognised that developing eco-friendly industries was crucial for sustainable urban development. 20 years ago, Shenzhen began to aggressively promote the development of green economies and industries, such as the circular economy and new energy batteries. One of the most iconic examples of Shenzhen's commitment to sustainable and green development is its public transportation system's conversion to green energy. Shenzhen has become the world's first city where all taxis and buses are powered by new energy vehicles. This successful transformation has been a driving force behind the growth of the new energy vehicle industry and companies like BYD.

An inclusive and open innovation environment attracts global talent. Shenzhen is a city of immigrants, a city that embraces innovation and accepts failure. Here, no one considers failure to be shameful or embarrassing; perhaps most entrepreneurs and startups have experienced failure. It is this very atmosphere that draws individuals who have faced

setbacks in their pursuits elsewhere in China and are eager for greater challenges, as well as a diverse range of international talent.

A market mechanism committed to supporting the growth of private enterprises. Throughout the development of Shenzhen, numerous state-owned enterprises hailing from cities such as Beijing and Guangzhou played a role. However, with the progression of the city and its industries, these state-owned enterprises now account for a diminishing share in the city's economic landscape. A multitude of private enterprises has flourished. In Shenzhen, private enterprises have achieved remarkable statistics in six '90%' categories: 1) more than 90% of innovation-oriented companies are private; 2) over 90% of R&D institutions are set up within private enterprises; 3) over 90% of R&D personnel are employed by private enterprises; 4) over 90% of R&D funding is provided by private enterprises; 5) over 90% of utility model and design patents come from private enterprises; and 6) over 90% of major scientific and technological project patents originate from private enterprises.

A service-oriented government that is more closely aligned with the growth of the industry. The government of Shenzhen is committed to serving industry and innovation. Instead of placing emphasis on so-called government subsidies, the Shenzhen government focuses on creating a level playing field for innovation and establishing a policy framework that is conducive to technological advancements and the adoption of new products. Shenzhen consistently amends relevant laws and regulations to cater to the demands of emerging industries and the application of new technologies. The city leverages its urban context to nurture innovative businesses. For instance, it offers access to real-world scenarios within its subway and bus systems, allowing companies to develop and refine unmanned driving and AI technologies.

It is fair to say that Shenzhen is both the 'most global' and the 'most Chinese' city. Its 'most global' aspect is reflected in its respect for the market, enterprises and talent, which is common among other world-class international cities. However, Shenzhen is also 'most Chinese' in its boldness to open up urban scenarios, continually pushing the boundaries

of existing policies and regulations, and adapting to the rise of new technologies, products and industries. It is this very spirit of openness and Chinese characteristics that has made Shenzhen a hub of scientific discovery and technological innovation.

Journal of Economic Literature (JEL) codes: O25, O31, O32, O33, O38, R11, R58

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1 Introduction

Shenzhen, as a vital hub of innovation in China, serves as a mirror reflecting China's innovation landscape to a considerable extent. Innovation has propelled the city's continual upward trajectory. Meanwhile, Shenzhen is at the forefront of innovation in various domains across China. Over the span of 40 years, Shenzhen has transformed from an obscure agricultural county on the border into a bustling economic centre in China and a global hub for technological innovation, creating a miracle in world development history. The experiences and practices of Shenzhen have, in many instances, become integral components of the "China model" and "China's experience." Overall, the success of Shenzhen can be largely attributed to its respect for the market and enterprises, and commitment to fostering innovation.

2 China's innovation and innovative Shenzhen

More than 40 years ago, Shenzhen was nothing more than a remote fishing village adjacent to Hong Kong (Xu, 2022). Its transformation began with the establishment of the Shenzhen Shekou Industrial Zone, gradually evolving into a city known for its technology, manufacturing and innovation. Shenzhen's local GDP has surged from just RMB 1.97 billion (equivalent of USD 1.32 billion as at December 31, 1979) in 1979 to a staggering RMB 3.46 trillion (equivalent of USD 488.5 billion as at December 31, 2023) by 2023 (Wang & Liu, 2024) – a growth of nearly 17,500 times. Shenzhen, reputed as China's technology capital and a global manufacturing powerhouse, has undergone an astonishing transformation from a small fishing village to an international hub of innovation in a mere 45 years. Home to global giants like Huawei, Tencent, BYD, Dajiang-Innovation (DJI), BGI Genomics, China International Marine Containers (CIMC), China Merchants Group (CMG) and Ping An Insurance, the city also nurtures a thriving ecosystem of startups in areas such as electronics, biotechnology, artificial intelligence, hydrogen energy and the low-altitude economy. Shenzhen stands as a testament to the wonders of urban development and represents a typical example in global sci-tech innovation and industrial progress.

2.1 Innovation in China results from the collective efforts of cities engaging in independent exploration

The country's industrial innovation is driven from the bottom up, with cities taking the lead in implementing innovation strategies. In recent years, Chinese cities have displayed numerous achievements in economic growth and innovation-driven development, particularly in enhancing the *quality* of development. Among them, Shenzhen can be regarded as the 'pacesetter' of innovation in China. In its early stages of development, Shenzhen

faced scepticism. During the establishment of the Shekou Industrial Zone, to gain recognition from the central government for its innovative model, Shenzhen strategically placed billboards along Deng Xiaoping's inspection route in 1992, bearing slogans like 'Time is Money, Efficiency is Life.'[49] This move aimed to secure support and approval from the central government for Shenzhen's development and reform model. Currently, as China's economic special zone and technology hub, Shenzhen not only fuels regional growth as a pivotal driver of national economic expansion but also mirrors the country's sci-tech innovation and economic development on a national scale. It plays a significant role in both showcasing and leading China's progress.

2.2 Shenzhen's accomplishments are the result of the innovation of countless enterprises

Since the reform and opening up, China has pursued innovation through two primary avenues. One is through reliance on research institutes and universities, where the government sets the agenda and drives progress through annual science and technology initiatives. The other is exemplified by Shenzhen. Without national-level research institutions or renowned universities, innovation in Shenzhen relies mainly on enterprises, which conduct independent research aligned with market demands. Enterprises, especially private ones, are key contributors to Shenzhen's development. From DJI's drones to BYD's new energy vehicles and BGI's genetic testing services, they have all emerged from initial scepticism to become industry leaders. Today, Shenzhen has entered a stage of urban development primarily driven by innovation. In 2023, the added value of strategic emerging industries in Shenzhen accounted for 41.9% of GDP, while the added value of modern services comprised 76.3% of the total added value of services (Wang & Liu, 2024).

[49] Original slogan in Chinese: *时间就是金钱，效率就是生命.*

Picture 1. A fishing village in Shenzhen in the early 1980s (archive photo)

Source: Xu (2022)

3 Diversified development infuses the city's industries with vitality

The vitality of Shenzhen as a city stems from its diverse industries, while its sustainable innovation owes greatly to the continual evolution of its industrial ecosystem and the ongoing expansion of its industrial value chains. While the industrial economy rapidly developed, Shenzhen did not confine itself to single-track development such as export processing and traditional manufacturing. Instead, it has actively bolstered its capabilities in scientific research and development, gradually establishing a diverse landscape of sci-tech innovation clusters. Amidst the global shifts in industrial trends and innovation, Shenzhen continues to nurture new industries, constantly tapping into the intrinsic dynamics of urban industrial development. From being home to China's first national-level science and technology park in the 1980s to the high-tech industrial development zone in the 1990s, followed by

events like the China Hi-Tech Fair (CHTF), and the establishment of institutions such as the Research Institute of Tsinghua University in Shenzhen (RITS) and the PKU-HKUST Shenzhen-Hong Kong Institution in the early 21st century, Shenzhen has closely followed global trends in industries such as electronics and information technology. It has transitioned from the basic processing model of "shop at the front, factory at the back"[50] to the high-tech driven model of "industry setting the agenda, and research answering questions."[51] Shenzhen's pillar industries have evolved from outsourced processing and export-oriented manufacturing to high-tech and strategic emerging industries. Today, Shenzhen is expediting the cultivation of future industries such as quantum computing, brain science and brain-like intelligence.

3.1 From processing trade to traditional advantageous manufacturing

Leveraging its advantage in opening up, Shenzhen initially undertook the transfer of mid-to-low-end industries from Hong Kong, Taiwan, Japan, South Korea and others, in developing its processing trade. Shenzhen's industrial journey began in the Shekou Industrial Zone, with the establishment and operation of the first Sino–foreign joint venture, Zhonghong Industrial Gas, followed by the influx of foreign enterprises such as Sanyo Electric, Kader Toys and Guangdong Float Glass (nowadays: CSG Holding Co., Ltd.). With its advantages in cheap labour and location, by the end of 1991, Shenzhen had attracted over 7,000 companies operating in the outsourced processing and export-oriented manufacturing sector (Duan, 2024). By 1998, Shenzhen had established a complete industrial system, particularly laying a solid foundation for subsequent industrial innovation in electronic information manufacturing. Thereafter, Shenzhen gradually expanded its

[50] In Chinese: *前店后厂*

[51] In Chinese: *产业出题、科研答题*

business from initial raw material processing to upstream and downstream industries such as R&D, design, marketing and services, forming eight traditional advantageous industries: underwear; watches; clothing; jewellery; leather goods; eyewear; furniture; and industrial design. Taking the design industry as an example, Shenzhen now hosts over 38,000 creative design enterprises and has established 72 cultural and creative industry parks such as OCT Loft Creative Culture Park and Shenzhen Design Industrial Park. In 2023, the revenue of Shenzhen's creative design industry exceeded RMB 1 trillion (Liu et al., 2024).

3.2 From traditional manufacturing to high-tech manufacturing

Around 1999, Shenzhen began its gradual shift towards developing high-tech industries. In October 1999, Shenzhen hosted its inaugural CHTF. It was during this event that the founder of Tencent secured the first external venture capital investment – USD 2.2 million from IDG Capital and Pacific Century Cyber Works. The CHTF marked the commencement of Shenzhen's evolution into a technology hub, initiating a comprehensive transformation of the city's development model through the cultivation of high-tech industries. By 2000, Shenzhen had identified a total of 212 high-tech enterprises, with the annual output value of high-tech products reaching RMB 106.4 billion. The output value of high-tech products with independent intellectual property rights amounted to RMB 53.2 billion, representing 50.0% of the total output value of high-tech products (Shenzhen Municipal Bureau of Statistics, 2008). Shifting from outsourced manufacturing to independent innovation, the high-tech industry solidified its position as the primary driver of urban economic growth.

3.3 From high-tech manufacturing to sci-tech innovation

After the 2008 global financial crisis, Shenzhen began strategising the development of strategic emerging industries.

In 2009, Shenzhen took the lead nationwide in planning the development of industries such as biotechnology, new energy and the internet. Subsequently, from 2011 onward, it rolled out plans to revitalise and develop four major strategic emerging industries: new materials, cultural and creative industry, next-generation information technology, and energy conservation and environmental protection. Seeking to secure a foothold in future technological competition, Shenzhen proposed the development of five future industries: marine; aerospace; life sciences and health; defence industry and robotics; wearable devices and smart equipment from 2013 onwards. By 2017, the added value of Shenzhen's emerging industries totalled RMB 918.355 billion (equivalent of USD 141.15 billion as at December 31, 2017), accounting for 40.9% of GDP, up from around 30% in 2012 (Zheng, 2020). During this period, Huawei and Tencent experienced rapid growth and gradually became Fortune Global 500 companies. Huawei became the earliest Chinese private technology firm to enter the Fortune Global 500 in 2010, ranking 397th at the time (ranked 111th in 2023). Tencent entered the Global 500 in 2018, ranking 478th that year (ranked 147th in 2023). Drone manufacturer DJI began rapid development in 2012 and became the world's largest drone manufacturer in just a few years.

3.4 From business clustering to cluster-based innovation

As industries continue to expand, Shenzhen's industrial landscape has transitioned towards a cluster-based development model, fostering greater depth and breadth along the supply chain. In recent years, Shenzhen has remained committed to industrialisation and bolstering its manufacturing sector, proposing the '20+8' industrial cluster initiative in 2022. By 2023, Shenzhen boasted 24,700 national-level high-tech enterprises (Chen & Zeng, 2024), with over 60% of the value-added in large-scale industries coming from advanced and high-tech manufacturing. Emerging sectors like network communication, integrated circuits, high-end equipment manufacturing, new materials and biopharmaceuticals accounted

for 41.9% of GDP (Shenzhen Municipal Bureau of Statistics, 2024). Shenzhen aims to position itself at the forefront of global technology and industrial development by strategically planning the growth of strategic emerging industries and future sectors, refining the 8 strategic emerging industries into 20 distinct clusters (Industry and Information Technology Bureau of Shenzhen Municipality, 2024). Enterprises and industrial clusters grounded in sci-tech innovation have flourished in Shenzhen, emerging as the city's new economic pillar.

Table 1. Clusters of strategic emerging industries and future industries in Shenzhen

Seven Clusters of Strategic Emerging Industries	Next-generation Electronic Information (Network and Communication; Semiconductor and Integrated Circuits; Ultra-high-definition Video Display; etc.)
	Digital Fashion (Software and Information Services; Artificial Intelligence; Digital Creativity; Modern Fashion)
	High-end Equipment (High-end Equipment and Instruments; Low-altitude Economy and Aerospace; Robotics)
	Green and Low-carbon Industry (New Energy; Safety, Energy Conservation and Environmental Protection; Intelligent and Connected Vehicles)
	New Materials (High-performance Materials)
	Biopharmaceuticals and Health (Biopharmaceuticals; High-end Medical Devices; etc.)
	Marine Economy
Eight Major Future Industries	Synthetic Biology
	Optoelectronic Information
	Intelligent Robotics
	Cell and Gene
	Brain Science and Brain-machine Engineering
	Deep Earth and Deep Sea
	Quantum Information
	Advanced New Materials

Source: Industry and Information Technology Bureau of Shenzhen Municipality (2024)

4 Green power drives sustainable development

Green and low-carbon innovation is a pivotal domain within the ongoing wave of technological revolution and industrial transformation. Advancing towards a new industrial era necessitates a comprehensive drive towards green industrial development, and fostering a resource-efficient and environmentally friendly production framework. During its industrialisation process, Shenzhen has also faced the challenge of environmental degradation. Early on, the city recognised that developing eco-friendly industries was crucial for sustainable urban development. 20 years ago, Shenzhen began to aggressively promote the development of green economies and industries, such as the circular economy and new energy batteries, positioning the green development of industries as the primary path for Shenzhen's development.

Early on, Shenzhen adopted a clear stance: "Heavily polluting projects are generally not welcomed, while projects with high technological sophistication and minimal or no pollution are encouraged" (Xiao, 2022). Measures such as the publication of a "list of environmentally restricted development projects" on a regular basis and the establishment of the "basic ecological control line" (Xiao, 2022), covering half of the city's area, ingrained the essence of industrial greening into Shenzhen's urban fabric. In recent years, Shenzhen has ramped up efforts in industrial energy conservation, intensified comprehensive resource utilisation, and strengthened initiatives to cultivate safe, energy-efficient and eco-friendly industrial clusters. Shenzhen has elevated the level of green development, promoting industrial carbon peaking with multiple measures. By 2022, Shenzhen had already achieved an energy consumption per unit of GDP below 0.16 tons of standard coal per RMB 10,000 (equivalent of USD 1435.83 as at December 31, 2022), and carbon emissions per unit of GDP below 0.2 tons of

carbon dioxide per RMB 10,000 (equivalent of USD 1435.83 as at December 31, 2022), which is one third and one fifth of the Chinese average, respectively (Zou & Shen, 2023).

4.1 Promoting green energy utilisation

Shenzhen's proactive pursuit of green energy utilisation is exemplified in its transformation of public transportation. Shenzhen stands as the world's first city with an entire fleet of taxis and buses comprising new energy vehicles. This successful transition to green energy sources has not only propelled the growth of Shenzhen's new energy vehicle industry but has also bolstered the development of companies like BYD. By 2024, the penetration rate of new energy electric vehicles in Shenzhen soared to an impressive 67.9% (Dou, 2024). Driven by the city's green development strategy and a plethora of green application scenarios, Shenzhen's new energy vehicle industry has experienced exponential growth, with the industrial chain ecosystem gradually taking shape. This has culminated in the establishment of a comprehensive industrial chain encompassing vehicle manufacturing, power batteries, motor control, autonomous driving, intelligent cabins, charging infrastructure and automotive aftermarket. This integrated ecosystem, led by industry giants like BYD, has fostered high synergy within the industrial supply chain. Concurrently, Shenzhen is aggressively advancing the construction of a 'city of supercharging,' aiming to establish 300 supercharging stations by 2025, with the supercharging stations to gas stations ratio reaching 1:1, a pioneering initiative nationwide. By 2035, Shenzhen is projected to have over 2,000 supercharging stations, ensuring widespread access to charging infrastructure along every road (Wang, 2023).

4.2 Facilitating the green transformation of industries

A long-standing commitment in Shenzhen is to guide enterprises towards greener, low-carbon transformation, prioritising green

renovation, underpinned by innovative green technologies and bolstered by robust policy frameworks and standards. The Green Manufacturing Project has been a focal point, yielding tangible results, alongside active engagement in carbon emission control and trading. As of June 2023, Shenzhen boasts the successful establishment of 79 national-level green factories, 14 green supply chains, 2 green parks, 92 green design products and 13 demonstration enterprises for green product design (Peng, 2023). Notably, in 2022, the China National Offshore Oil Corporation (CNOOC) Shenzhen branch achieved significant energy savings of 74,000 tons of standard coal and a reduction of 135,000 tons of carbon dioxide emissions, which is roughly equivalent to planting 1.22 million trees (China National Offshore Oil Corporation, 2023).

4.3 Emphasising the development of green consumption

In parallel with the development of new energy vehicles, Shenzhen is extending the new energy consumption chain, actively fostering green industries like advanced energy storage. In 2023, the city unveiled the world's first integrated photovoltaic charging, discharging and storage network, along with the 2.0 version of a virtual power plant (Wang, 2023). These initiatives are part of Shenzhen's vision to become a world-class automotive and supercharging city, and to establish itself as a vanguard in digital energy innovation. Over many consecutive years, Shenzhen has been hosting events such as climate science popularisation in schools, the International Low Carbon City Forum and the Handle Climate Change Film Festival. As of 2022, Shenzhen has established 61 public environmental education facilities (Li, 2024), successfully integrating the concept of green and low-carbon living into the fabric of the city, and a virtuous cycle of social carbon reduction is gradually taking shape.

5 An inclusive and open environment attracts global innovators

Shenzhen is a city of immigrants, a city that embraces innovation and tolerates failure. Here, no one considers failure to be shameful or embarrassing; perhaps most entrepreneurs and startups have experienced failure. It is this very atmosphere that attracts individuals who have faced setbacks in their pursuits elsewhere in China and are eager for greater challenges, as well as a diverse range of international innovators.

5.1 An innovators' haven of inclusiveness and openness

A city's attitude toward failure reflects its capability to innovate. It is Shenzhen's tolerance for failure and encouragement of exploration that have led to numerous pioneering endeavours and made it the leading city for the private economy, where giant firms stand tall and SMEs thrive. Many notable figures, from Yuan Geng, the former vice-chairman of the Shekou Industrial Zone and China Merchants Group, Ren Zhengfei of Huawei, Ma Mingzhe of Ping An Insurance and Terry Gou of Foxconn, to Ma Huateng of Tencent, Wang Chuanfu of BYD and Frank Wang of DJI, all started as young, unknown individuals in Shenzhen and grew into prominent entrepreneurs under the city's innovative and inclusive environment. They have become bright stars in the business history of China and even that of the world. Statistics show that in 2023, Shenzhen saw 565,000 new market entities, bringing the total to 4.226 million (Peng, 2024), meaning that in Shenzhen, 1.1 new enterprises are born every minute and one out of every five people is a boss. This density of entrepreneurship is much higher than that of cities like Beijing, Shanghai and Guangzhou, ranking first among China's large and medium-sized cities. In the European Commission's list of the top 2,500 corporate R&D spenders, Huawei has been ranked first among Chinese enterprises for many years and once ranked second globally. In the latest report

released at the end of 2023, Huawei and Tencent were the only two Chinese enterprises to make it into the top 20, both hailing from Shenzhen (Zhang et al., 2024). Additionally, *Regulations of Shenzhen Special Economic Zone on Personal Bankruptcy* have established a failure exit mechanism for honest and trustworthy entrepreneurs who have experienced business failures, providing a 'safety net' for entrepreneurs coming to Shenzhen and further stimulating the entrepreneurial enthusiasm of market players (Justice Bureau of Shenzhen Municipality, 2021).

5.2 Basic research to address gaps in sci-tech innovation

Shenzhen's journey in scientific and technological development can be traced through phases, including the exploratory stage of outsourced processing and export-oriented manufacturing, followed by periods of imitation-based innovation and absorption, and finally, independent innovation and development. This trajectory has propelled Shenzhen to achieve a notable feat: ranking second globally in the Shenzhen – Hong Kong – Guangzhou science and technology cluster for three consecutive years. Over the past decades, Shenzhen has transitioned from catering to industrial demands to supplying technological expertise. This transformation has shifted Shenzhen from a 'science and technology desert' to an 'innovation oasis,' currently pivoting towards prioritising basic research and fostering original innovation. By the end of 2022, Shenzhen had established a total of 3,223 innovation hubs, including national, provincial and municipal key laboratories, engineering technology research centres and corporate technology research centres, among others, with 153 at the national level and 1,278 at the provincial level (Wen, 2023a).

5.3 Strengthening government support for basic research

To ensure sustained investment in sci-tech innovation, Shenzhen has fortified government support for basic research through

local legislation. Shenzhen mandates that no less than 30% of municipal scientific research funds must be allocated annually to basic research and applied basic research. In 2022, Shenzhen's investment in basic research amounted to RMB 12.2 billion, elevating the proportion of R&D investment in society by 2.5 percentage points to reach 7.25%. This marked the first time Shenzhen surpassed the average levels of both Guangdong Province (6.9%) and China (6.5%) (Wen, 2023b).

Bridging gaps to enhance higher education services. As early as 1983, Shenzhen built its own university, Shenzhen University. By 2000, the city government had started collaborations with Tsinghua University, Peking University and Harbin Institute of Technology in a bid to establish a number of universities and research institutes. In 2007, Shenzhen further reinforced its educational landscape with the establishment of the Southern University of Science and Technology (SUSTech), bolstering the city's role in nurturing talent and fostering innovation in science and technology. Since 2016, Shenzhen has ramped up efforts, creating institutions like the Tsinghua Shenzhen International Graduate School (Tsinghua SIGS), Shenzhen Technology University, Harbin Institute of Technology (Shenzhen) and Sun Yat-sen University Shenzhen Campus, alongside collaborative ventures with overseas counterparts such as the Chinese University of Hong Kong (Shenzhen) and Shenzhen MSU-BIT University. Today, Shenzhen boasts a roster of 16 universities (Qin, 2024).

5.4 Creating platforms to attract global sci-tech talent

In tandem with its research endeavours, Shenzhen has been actively attracting talent from across the globe. Initially, the focus was on attracting international talent through overseas startup teams. In 2008, for instance, BGI (founded by a postdoctoral research team from the University of Washington) answered Shenzhen's call (Yantian District People's Government of

Shenzhen, 2008), while Royole Technologies, founded by three Stanford returnees, soared to a unicorn valuation of USD 6 billion (Ma, 2020). In recent years, the city's efforts have expanded from start-up teams to renowned scientists and Nobel Prize-winning teams. Shenzhen has now established over ten Nobel Prize labs, led by Nobel laureates or Turing Award recipients. These distinguished individuals are required to spend at least one month working in Shenzhen annually (Qian & Wang, 2020). In a significant move in 2022, esteemed scientist Yan Ning resigned from Princeton University to return to China for full-time work, lending her expertise to the establishment of the Shenzhen Medical Academy of Research and Translation, a novel research institution focusing on the translation of research achievements and talent cultivation (Chen, 2022).

6 A market mechanism committed to supporting the growth of private enterprises

Shenzhen is a fertile ground for the development and innovation of the private economy. Here, businesses dare to innovate, encouraged by a government that fosters the spirit of innovation. As a result, private enterprises flourish in this ecosystem. Not only does Shenzhen boast a multitude of private technology firms leading their respective industries with robust R&D capabilities and a solid foundation in terms of intellectual property, but it is also a primary hub for China's unicorn companies. The city nurtures numerous specialised, differential, refined and innovative (SDRI) enterprises, brimming with vitality and growth potential.

6.1 Developing an ecosystem that supports innovation in the private economy

Shenzhen has developed an innovation ecosystem with enterprises as the primary players, fostering efficient collaboration among industry, universities and research entities. In 2022, Shenzhen's R&D investment reached 7.25% of its GDP, with private enterprises contributing a staggering 94.0% of the total R&D investment of the society (Chen, 2023). In Shenzhen, private enterprises have achieved remarkable feats marked by six different '90%' figures: 1) more than 90% of innovation-oriented companies are private; 2) over 90% of R&D institutions are set up within private enterprises; 3) over 90% of R&D personnel are employed by private enterprises; 4) over 90% of R&D funding is provided by private enterprises; 5) over 90% of utility model and design patents come from private enterprises; and 6) over 90% of major scientific and technological project patents originate from private enterprises (Su, 2023). Across various metrics such as enterprise count, entrepreneurial density, sci-tech innovation achievements and the number of industry leaders, Shenzhen's private economy ranks among the nation's best. In the 2023 list of China's top 500 private enterprises released by the All-China Federation of Industry and Commerce (ACFIC), 4 of the top 10 hail from Shenzhen (All-China Federation of Industry and Commerce, 2023). For example, in the drone industry, an innovation ecosystem has flourished, spearheaded by companies such as DJI, Autel Robotics and Chasing-Innovation Technology, with widespread societal engagement and support fuelling the industry's growth.

6.2 Commitment to continually strengthening intellectual property protection

Over its 40-year history of reform and opening up, the city has seen numerous new market players and private enterprises emerge amidst intense market competition. From Huawei's

founder Ren Zhengfei, who started the company as a technology professional, to the property rights reform in the 1990s when state-owned enterprise employees in Shenzhen began holding shares, to the rapid rise of numerous emerging industry companies like DJI, Shenzhen's path of reform and opening-up is a miniature of China's pursuit of property rights reform and the evolution of its ownership structures. Shenzhen considers intellectual property (IP) protection crucial to fostering a conducive business environment and views sci-tech innovation and intellectual property protection as key drivers of the city's growth. In recent years, in tandem with the ongoing rollout of judicial norms for IP protection, Shenzhen has taken the lead in developing an internationally leading IP protection framework. This framework includes digital IP protection, a pioneering model of cases handled by technology investigation officers and credit commitment mechanisms in emerging fields. These initiatives have substantially strengthened Shenzhen's IP protection architecture, securing the city's innovative endeavours.

6.3 Enhancing public services to better accommodate the needs of enterprises

Unlike private enterprises, Shenzhen's state-owned enterprises (SOEs) are more specialised in urban infrastructure construction and public services. While the former serves as the primary driver of innovation, the latter acts as a development safeguard. These two sectors complement each other, fostering the growth of Shenzhen's modern industrial system and high-tech industries. In recent years, Shenzhen has been encouraging state-owned enterprises to play a more active role in developing industrial spaces, enabling them to act as operators in the construction and management of sci-tech innovation infrastructure. This includes constructing industrial buildings suitable for the development of emerging industries and providing them to innovation-oriented SMEs at relatively low prices.

7 A government supporting industrial development

The Shenzhen government is committed to serving as a facilitator for industry and innovation, embracing a 'hands-off unless necessary, and responsive when requested' approach. It steers away from relying heavily on subsidies, instead concentrating on levelling the playing field and fostering an enabling policy environment conducive to technological advancements and the adoption of new products.

7.1 Cultivating a fair business environment

Initiatives range from reinforcing property rights protection and easing market access to encouraging fair competition and refining credit supervision systems. The city has also focused on enhancing the level of support factors and streamlining government services, including the implementation of instant approval for business registrations and the integration of government and banking credit data for mutual recognition of documents. Shenzhen has long viewed a business-friendly environment as crucial for economic growth, innovation and market dynamism. Since 2018, optimising the business environment has been a primary goal, earning Shenzhen the reputation of being a national leader in this aspect. Currently, Shenzhen hosts approximately 4.08 million commercial entities, with a business density of 232.39 entities per thousand people (Deng, 2023), ranking among the nation's top performers. In recent years, Shenzhen's efforts to enhance the business environment have expanded beyond registration processes to include bankruptcy and exit mechanisms. Initiatives have included lowering thresholds of pre-reorganisation for bankrupt businesses, addressing gaps in oversight of individual bankruptcy administrators, and establishing specialised or simplified bankruptcy procedures for SMEs. As reported by the All-China Federation of Industry and Commerce's 2023 *Evaluation*

of Business Environment by Ten Thousand Private Enterprises, Shenzhen has earned the distinction of being the "Best-Praised City for Business Environment" in China for four consecutive years (Yuan, 2023).

7.2 Supporting enterprises by offering them access to real-world scenarios

In Shenzhen, supporting enterprises goes beyond simple financial subsidies: it involves providing them with practical application scenarios and access to market opportunities. BYD's success story is not just about its commitment to sci-tech innovation, but also owes much to Shenzhen's support for the new energy sector. Shenzhen has long been a pioneer in urban electrification of public transportation, replacing traditional buses with new energy vehicles and creating market demand for enterprises. Furthermore, More importantly, Shenzhen has become the ultimate showcase for BYD's 'electrification of urban public transport' strategy, helping it transition from a national player to a global one. This has attracted international interest, with delegations from transportation sectors in the United States, the United Kingdom, Brazil and elsewhere visiting Shenzhen to learn from BYD's advancements. In recent years, Shenzhen has continually made adjustments in laws and regulations to accommodate new industries and technologies, providing urban scenarios for innovation-oriented enterprises to thrive. For instance, opening up subway, bus and taxi scenarios to facilitate training in unmanned driving and AI technologies.

7.3 Welcoming global investors

Shenzhen's growth story is deeply intertwined with its commitment to openness and international investment. Its early development relied on industrial parks that attracted foreign investment, drawing manufacturing giants from Japan, Hong Kong and Taiwan. In recent years, Shenzhen has further eased

access to foreign investment and expanded opportunities in sectors such as telecommunications, healthcare, finance and energy through regional pilot programmes, enhancing its appeal to global investors. Presently, over 300 Fortune Global 500 companies from outside China have made Shenzhen their home (Yue, 2023). In 2023, the city housed 8,002 foreign-invested enterprises. In the first two months of 2024 (Zou, 2024), the number of newly established foreign-invested enterprises in Shenzhen reached 1,121, a nearly 30% increase year-on-year, accounting for 15.7% of the national total, with the number of foreign enterprises in the scientific research and technology service industry growing by 97.1% (He, 2024).

7.4 Enhancing digital government services

Shenzhen continues its efforts to streamline operations for micro, small and medium-sized enterprises (MSMEs) through digital government platforms. For instance, the 深i企 (Shen i Qi) online platform offers a comprehensive range of services in eight modules, including policy updates, government affairs and financial support. As of November 2023, the platform boasted 2.92 million individual users and 2.72 million business entity users, providing access to over 14,000 corporate policies and more than 3,500 funding support initiatives (Yue, 2023).

8 What can developing countries learn from Shenzhen's experience?

Shenzhen is both the 'most global' city in China and the 'most Chinese' city in the world. It is 'most global' because its successful experience is drawn from practices of globally developed cities such as Silicon Valley, Hong Kong and Singapore. Like other world-class cities, Shenzhen respects the market, enterprises

and talent. Yet, it is also the 'most Chinese' city, daring to open up urban scenarios for enterprises, to continuously go beyond existing policies and regulations to adapt to new technologies, products and industry development, and ready to foster a first-class environment for innovation. It is this spirit of openness and Chinese characteristic that has made Shenzhen a city of sci-tech innovation. Shenzhen's development experience holds valuable lessons for cities worldwide, particularly for developing countries.

8.1 Emphasis on fostering a favourable business environment

The key to a city's appeal to businesses, capital and talent lies in its business environment. Shenzhen prioritises two key aspects. Firstly, it emphasises a balanced relationship between enterprises and the government, exemplified by its 'small government' approach that minimises interference in the market, with the government's priority being to serve the enterprises. Secondly, it invests heavily in urban public services such as music halls, libraries, city parks, top hospitals and high-quality schools, aiming to attract talent by creating a better living environment.

8.2 Dedication to inclusive and fair policies

Shenzhen's industrial policies are marked by a relative competition neutrality, where policies are inclusive and fair, seldom tailored to individual companies or certain types of businesses. Typically, the Shenzhen government introduces broad and sector-specific support policies, with enterprises applying based on predefined requirements. Generally, those meeting the requirements can enjoy corresponding policy support. In tendering processes for government projects and procurement, local enterprises in Shenzhen, those from other cities and foreign invested ones are treated equally, ensuring fair participation and competition for all.

8.3 Commitment to opening up urban scenarios to nourish industries

With a population exceeding 17 million and a density of over 7,000 people per square kilometre (Zhang, 2024), Shenzhen serves as a vibrant testing ground for industrial innovation in the construction of a new smart city. To drive industrial development, the Shenzhen government is keen on further opening up urban public services. From allowing shared bicycles on city roads in the past to currently facilitating drone aerial performances in city parks, the opening up of urban scenarios provides ample market opportunities for enterprises. For example, in the field of autonomous driving, Shenzhen has granted relevant taxi operation licenses to autonomous driving companies, thus facilitating the development of the industry.

8.4 Resolute and timely policy adjustments to support new economies, technologies and products

Endowed with local legislative powers, Shenzhen promptly adjusts local laws and regulations to foster a conducive legal environment for the development of new economies. For instance, legislation on big data and AI aims to eliminate or adapt outdated policies hindering industry development and sci-tech innovation.

8.5 Commitment to an inclusive urban cultural environment

Shenzhen embraces innovation and newcomers without discrimination, providing a favourable environment for innovators and entrepreneurs to thrive. Additionally, the city maintains relatively low barriers in areas such as healthcare, education and residency registration. The mentality of 'once you arrive, you're a Shenzhener' fosters a sense of belonging and value for countless newcomers in Shenzhen.

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Innovative Technologies in the Service of Sustainable Finance in Central Asia: The Current State and Bridging the Gaps

Aigul Kussaliyeva – Ainur Zhakupova

Although Central Asian countries contribute just over 1% to global greenhouse gas (GHG) emissions, they are among the most vulnerable to climate change. The major adverse effects include the shrinking of glaciers and reduced surface water flow, which pose significant threats to the regional economies, especially for the agriculture sector, which is essential for both economic stability and food security in Central Asia.

Central Asian countries are part of the global effort to address climate change. By committing to international agreements to reduce greenhouse gas emissions, they have aligned themselves with the global climate agenda. At the national level, they are implementing carbon neutrality strategies and plans for transitioning to a green economy. However, achieving these goals requires tremendous financial resources, which could strain government budgets in the region. Therefore, it is essential to attract funding for climate change initiatives and other green and sustainable projects.

The adoption of innovative, sustainability-focused financial instruments, such as green bonds, social bonds and sustainable development bonds, is gaining momentum globally, creating a robust sustainable finance market. To fully leverage the potential of these instruments and build sustainable finance markets, countries need to establish clear, transparent

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and standardised regulatory frameworks along with supportive financial sector infrastructure.

Among Central Asian countries, Kazakhstan has made significant progress in developing its local sustainable finance market. As the first country in the region to adopt green finance standards, Kazakhstan has seen over twenty issuances in this segment. Meanwhile, in Uzbekistan the government is a proactive user of debt instruments for sustainable development, becoming the first in the region to issue both sovereign bonds for SDGs (Sustainable Development Goals) and sovereign green bonds. Kyrgyzstan and Tajikistan have also entered the market with their first corporate green bonds. Turkmenistan lacks publicly available information on sustainable development bond issues. Overall, the sustainable finance market in the region now exceeds USD 2 billion.

Emerging economies are vigorously competing for investment, particularly in sustainable projects. To ensure that Central Asia's green transformation does not become burdensome for national budgets, it is critical for regional economies to enhance their sustainable finance markets and launch initiatives that boost the region's appeal to international investors in sustainable projects. This report proposes concrete steps to further develop and bridge the gaps in the sustainable finance markets of Central Asia, including innovative solutions, which are built around the following priority areas: standardisation, assessment, capacity building, encouragement and prioritisation.

Journal of Economic Literature (JEL) codes: G15, Q54, Q56

Keywords: sustainable finance, green finance, green bonds, sustainable bonds

1 Central Asia's contribution to global climate change and regional consequences

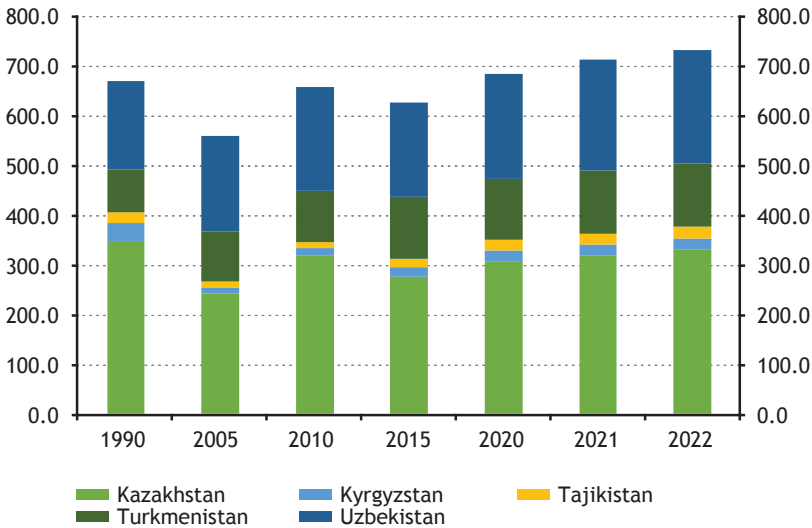
The Central Asian region is among the most vulnerable to climate change. According to the International Monetary Fund (IMF), temperatures in the region have risen by 1.5 °C over the last three decades, which is double the global average (Climate Centre, 2022). The main detrimental implications of climate change in the region are glacier retreat and reduced surface water flow. Over the last 50–60 years, climate change has reduced the surface area of Central Asian glaciers by 30% (Asian Development Bank, 2022). Glaciers are critical to the lives of Central Asians because they are sources for the region's largest rivers which are used to irrigate agricultural lands. Furthermore, the melting of glaciers causes such natural disasters as floods and landslides, which have become increasingly frequent and severe.

Climate change's negative effects in the region will worsen, causing an increase in socioeconomic challenges relating to Central Asia's energy, land and water resource management. Without coordinated efforts to address climate challenges, the repercussions of climate change will cost Central Asian countries 1.3% of GDP per year, crop yields will be reduced by 30% and water levels in the Amu Darya and Syr Darya rivers will fall by 15% by 2050 (World Bank, Asian Development Bank, 2022).

According to the Emissions Database for Global Atmospheric Research (EDGAR), Central Asian countries' total share in global GHG emissions in 2022 was 1.36%, with Kazakhstan accounting for 0.62%, Uzbekistan for 0.42%, Turkmenistan for 0.24%, Kyrgyzstan and Tajikistan for 0.04% each. The cumulative emissions of the Central Asian countries for the period 1990–2022 increased from 669.4 million tons of CO_2eq (carbon dioxide equivalent) to 732.4 million tons of CO_2eq. Compared to 1990, a slight reduction has been observed in Kazakhstan and Kyrgyzstan;

in Tajikistan, the indicator remained at approximately the same level, while in Turkmenistan and Uzbekistan, GHG emissions increased significantly over the specified period (EDGAR, 2022) (see Figure 1).

Figure 1. GHG emissions of Central Asian countries, million tons of CO_2eq



Source: Own compilation based on the Emissions Database for Global Atmospheric Research [EDGAR]

As part of the Paris Agreement, the Central Asian countries have undertaken obligations to reduce GHG emissions. As with other parties to the Paris Agreement, the countries of the region are adopting Nationally Determined Contributions (NDCs), which is a country's action plan to reduce emissions and adapt to climate change. The NDCs of the Central Asian countries set unconditional and conditional targets for reducing GHG emissions, ranging from 15–16% to 50% by 2030 compared to the base year. The Paris Agreement defines carbon neutrality as achieving zero carbon dioxide emissions with the goal of limiting global warming to 2 °C (aiming for 1.5 °C) by achieving a balance between anthropogenic emissions from sources and GHG emission removals by sinks in

the second half of this century. 137 countries globally, including Kazakhstan (by 2060), Kyrgyzstan (by 2050) and Uzbekistan (by 2060), have announced commitments to achieve carbon neutrality, setting ambitious goals for these economies which heavily rely on fossil fuels and therefore require colossal amount of investments to achieve net zero goals.

2 Financial sector's role in climate finance

The financial sector plays a vital role in advancing sustainable development and fostering responsible business practices by funding sustainable development projects and encouraging businesses to adapt to ESG (environmental, social, and governance) risks, thereby ensuring sustainable business models. Financial regulatory authorities and institutions in Central Asia, especially banks, are aligning with global sustainability trends by integrating ESG principles into their banking and investment activities.

In Kazakhstan, the Agency for Regulation and Development of the Financial Market has adopted a roadmap for implementing ESG principles in the regulation of the country's financial market. In accordance with this roadmap, financial institutions began voluntary ESG information disclosure in 2023, with mandatory disclosure required from 2024 as part of their annual reports. The financial regulator has also developed Guidelines for Environmental and Social Risk Management in Financial Institutions (ESRM) and issued guidance for calculating GHG emissions and assessing the carbon footprint of bank loan portfolios. The Kazakhstan Stock Exchange (KASE) requires that listed companies include ESG information in their annual reports. The Astana International Exchange (AIX) released ESG reporting guidelines for listed companies in June 2022 for voluntary use, transitioning to a 'comply or explain' basis in subsequent years.

Commercial banks in Kazakhstan are integrating ESG principles into their operations and producing sustainable development reports. Halyk Bank and Jusan Bank were recognised as the best financial companies in the ESG Disclosure Rating by PWC at the end of 2022, and they publish annual sustainability reports as standalone documents. The Development Bank of Kazakhstan stands out as an active issuer of green bonds and lender for green projects, particularly renewable energy projects. Halyk Bank and Bank CenterCredit offer green auto loans at reduced rates for purchasing electric vehicles. To support green projects, Kazakhstani banks can also use subsidies from the Damu Entrepreneurship Development Fund to offset a portion of the interest on green loans.

In Kyrgyzstan, the National Bank has identified the adoption of sustainable finance principles (green finance) as a key priority for further development of the country's banking system. It has also approved recommendations for identifying, monitoring and disclosing financial risks related to sustainable finance factors (ESG risks). In May 2023, the Kyrgyz Stock Exchange issued guidelines for compiling and publishing ESG reports, which are voluntary for all companies. Additionally, the Exchange has established listing criteria for sustainable finance instruments, verifier requirements and a list of approved verifiers. Kyrgyz banks are also embracing sustainable finance by offering green products. For instance, Doscredobank OJSC provides loans and installment plans for purchasing electric, hybrid or gas-powered vehicles, while Aiyl Bank OJSC became the first in the country to offer leasing options for electric vehicles.

In Tajikistan, Bank Eskhata OJSC was the first institution to implement an ESG policy and prioritise specific SDGs. In 2024, First Microfinance Bank CJSC plans to adopt ESG principles and gradually shift to green financing. Bank Arvand CJSC is also integrating ESG principles into its activities. Green auto loans are a popular loan product in Tajikistan's banking sector, as in

other Central Asian countries. Notable banks offering these loans include Amonatbonk State Savings Bank, Bank Arvand CJSC and Commerzbank of Tajikistan OJSC, with Amonatbonk alone issuing 84 green auto loans in 2023. Additionally, Bank Eskhata OJSC, Spitamen Bank CJSC and First Microfinance Bank CJSC provide green financing for various sustainable projects. Other banks are also in the process of introducing green financial products.

In Uzbekistan, the banking sector is also gradually adopting ESG concepts. In 2022, Uzpromstroybank was recognised by the international financial publication *Asiamoney* as the 'Best ESG Bank in Uzbekistan,' largely due to its notable collaboration with the IFC (International Finance Corporation) and the EBRD (European Bank for Reconstruction and Development) on transformation, green banking development and ESG implementation. The bank also received the AIFC (Astana International Financial Centre) award for 'Best Green Bank in the Central Asia Region' in 2021 for its contributions to green banking development. The banking sector in Uzbekistan is particularly active in green consumer lending for renewable energy projects. For example, banks such as JSCB Ipoteka Bank, JSCB Asia Alliance Bank, JSC Xalq Bank and JSC National Bank for Foreign Economic Activity of the Republic of Uzbekistan offer consumer loans for the purchase of renewable energy equipment.

Overall, among Central Asian financial sector players, Kazakh and Kyrgyz financial regulators and stock exchanges are at the forefront of implementing ESG regulatory requirements. Meanwhile, in Uzbekistan and Tajikistan, banks are most active in offering specialised green products, such as green loans for electric vehicles and renewable energy equipment, driven by high demand for these technologies from the local population and businesses.

3 Countries' financial needs to address climate change

Central Asian countries will need enormous amounts of financing to meet their climate commitments and transition to a low-carbon economy. According to World Bank estimates, investments in Central Asia's energy system would reach around USD 20 billion by 2030, including solar, wind and hydropower projects, as well as the modernisation of national and regional grids to increase interconnection.

In terms of individual countries' financial needs, the Strategy of Achieving Carbon Neutrality of Kazakhstan by 2060 estimates net investment in technologies that contribute to low-carbon development and carbon neutrality at USD 610 billion, with direct public investment accounting for a small share of 3.8% of all investments. More than half of the required investments, USD 386.3 billion, are existing and circulating investments in the economy that will be redirected from commodities sectors to greener industries, while the remainder, or USD 223.7 billion, are new investment resources (Strategy of Achieving Carbon Neutrality of Kazakhstan by 2060, 2023).

The entire anticipated cost of implementing mitigation and adaptation measures to meet Kyrgyzstan's climate change goals is USD 10 billion, which will be funded by the country's own resources, the private sector, international donors and state budget funding, with international financial support accounting for 63% of the expenses. This is a big expenditure for a lower-middle-income country prone to recurrent natural disasters (United Nations Framework Convention on Climate Change, 2021).

Uzbekistan will need USD 94 billion in funding to become carbon neutral (РБК Тренды, 2022). According to the Ministry of Finance of the Republic of Uzbekistan, the annual investment requirements for decarbonising Uzbekistan's electric power

industry until 2030 are anticipated to be USD 4 billion per year, or 4.8% of GDP (World Bank, Ministry of Economic Development and Poverty Reduction of the Republic of Uzbekistan, Regional Environmental Center for Central Asia, 2022).

According to the Green Economy Development Strategy of the Republic of Tajikistan for 2023-2027, the total amount of funds required for the implementation of the Strategy is TJS 21.6 billion (~ USD 2 billion), including TJS 12,818.4 million (~ USD 1 billion) from allocated funds from development partners and TJS 8,730.8 million (~ USD 800 million) from private sector investments; the rest is planned to be financed from the state budget. Foreign and domestic investments play a key role in funding the Strategy.

Overall, Central Asian countries may face costs ranging from almost 20% (Tajikistan) to about 300% (Kazakhstan) of national GDP to achieve carbon neutrality and the transition to a green economy (see Table 1).

Table 1. Climate finance needs of Central Asian countries

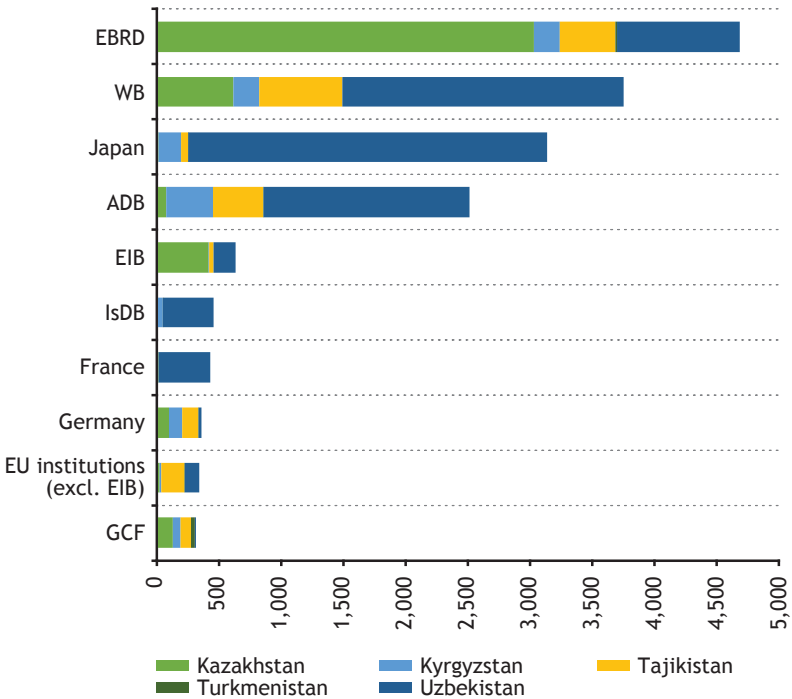
Country	Required financing, USD bn	Country's GDP, USD bn, 2022 (according to the World Bank)	Share of GDP, %
Kazakhstan	610	225.5	270%
Kyrgyzstan	10	11.5	87%
Tajikistan	2	10.5	19%
Uzbekistan	-	56.5	-
Turkmenistan	94	80.4	117%

Source: Own compilation based on United Nations Framework Convention on Climate Change (2021), РБК Тренды (2022), Strategy of Achieving Carbon Neutrality of Kazakhstan by 2060 (2023), Green Economy Development Strategy of the Republic of Tajikistan for 2023-2027 (2022), World Bank Open Data (2022)

The massive amount of funds needed to finance climate change mitigation and adaptation strategies in developing countries necessitates the mobilisation of funds from international financial sources. At the UNFCCC's (United Nations Framework Convention on Climate Change) COP15 in Copenhagen in 2009, developed countries pledged to raise USD 100 billion per year by 2020 for climate action in developing countries. Under the terms of the Paris Agreement, "developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation" (United Nations, 2015, Article 9.1). At the request of developed countries, since 2015 the OECD (Organisation for Economic Co-operation and Development) has been assessing progress towards developed countries' goal of providing and mobilising USD 100 billion of climate finance annually for climate action in developing countries, in line with the UNFCCC. According to data on climate-related development finance reported to the OECD Development Assistance Committee (DAC) Creditor Reporting System (CRS) over the period 2001–2021, Central Asian countries have collectively received more than USD 17 billion in climate-related development finance (hereinafter for the purposes of this report used as international climate finance).

Multilateral development banks play a key role in financing climate projects in developing countries, including in Central Asia: the top 5 MDBs include the EBRD (European Bank for Reconstruction and Development), WB (World Bank), ADB (Asian Development Bank), EIB (European Investment Bank) and IsDB (Islamic Development Bank). The leaders in providing bilateral climate finance to Central Asian countries are Japan, France and Germany. Among international climate funds, the largest amount of funding is provided by the GCF (Green Climate Fund) (see Figure 2).

Figure 2. Top 10 international sources by volume of climate finance in Central Asian countries, USD million, 2000–2021



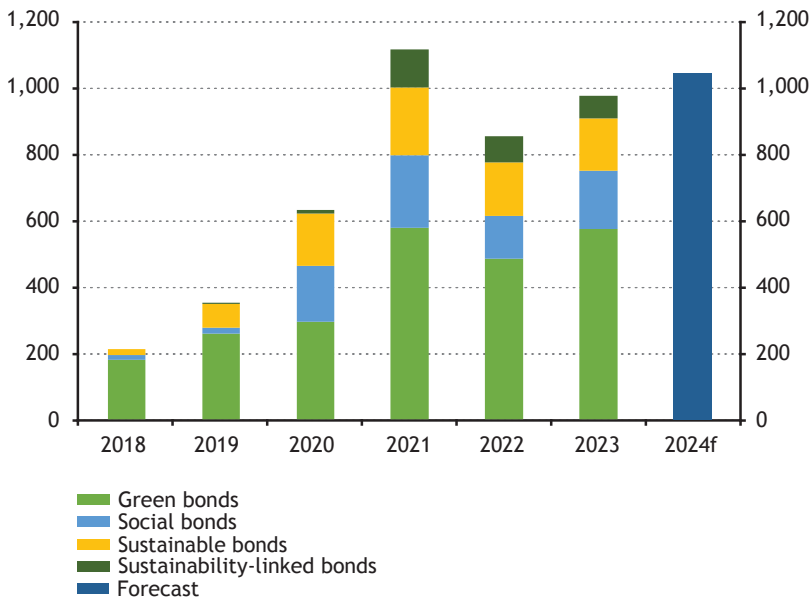
Source: Own compilation based on climate-related development finance data from OECD DAC CRS, authors' calculation

Implementing green initiatives and low-carbon technologies to prevent climate change and protect the environment requires a significant investment of capital. Despite the active participation of international climate funds and multilateral development banks in financing climate projects in the region, the financial needs for financing green transformation and decarbonisation of economies remain high. There is significant potential for governments and local businesses to raise funds in international debt markets by utilising novel financial instruments for sustainable development, such as issuing green bonds, i.e. bonds whose proceeds are allocated to support climate and environmental projects; this is a popular tool to raise capital for declared low-carbon

development targets. In addition to green bonds, sustainable finance instruments, such as social bonds, sustainability bonds and sustainability-linked bonds, have also grown in prominence over the last decade.

According to Environmental Finance estimates, the global volume of sustainable development bond issuance stood at USD 982 billion by the end of 2023. S&P Global Ratings expects that green, social and sustainability-linked bond issuance may reach USD 1 trillion by 2024 (Environmental Finance, 2024) (see Figure 3). Green bonds will continue to dominate sustainable financing markets, buoyed by rising demand for green projects in all regions. Issuers from middle- and low-income countries are also expected to want to boost their exposure to thematic bond issuances, given their significant unmet funding needs.

Figure 3. Global sustainable bonds issuance, 2018–2023 and forecast for 2024, USD billion



Source: Own compilation based on Environmental Finance, S&P Global Ratings

Central Asian countries are participating in the global trends in project financing, and the development of local markets for sustainable financing is gaining traction. According to available data, the Central Asian sustainable finance market is estimated to be worth more than USD 2.7 billion (see Figure 4), including:

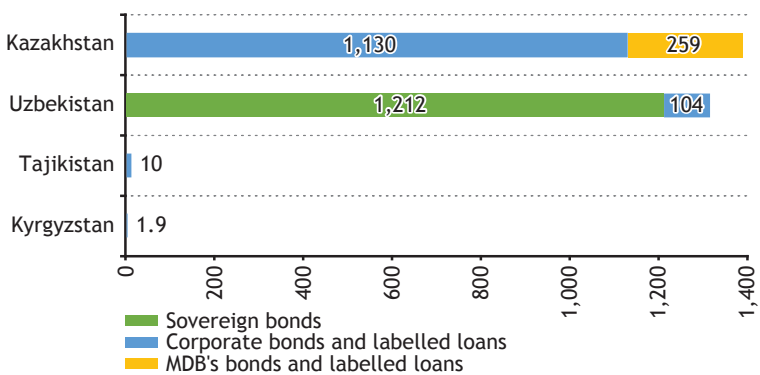
– Kazakh market: USD 1,389 million (registered green bonds, social bonds, sustainability-linked bonds, sustainability bonds and green loans of corporate sector issuers and MDBs labelled in accordance with international standards),

– Uzbek market: USD 1,316 million (sovereign SDG bonds, sovereign green bonds, corporate green bonds of Uzpromstroybank and SAIPRO GROUP LLC),

– Tajik market: USD 10 million (green bonds issued by the Bank Eskhata OJSC),

– Kyrgyz market: USD 1.9 million (green bonds issued by Doscredobank OJSC and gender bonds issued by Bank of Asia CJSC).

Figure 4. Sustainable finance markets volume in Central Asia, USD million
(calculated using official USD exchange rates of countries' central banks as of 1 May 2024)



Source: AIFC data (2024), OJSC "Bank Eskhata" (2024), UNDP Uzbekistan (2022), UNDP (2023), SPOT.UZ (2023), Ministry of Economy and Finance of the Republic of Uzbekistan (2024)

Out of the Central Asian countries, Kazakhstan has made the most progress in developing the local corporate sustainable finance market. The key was the establishment of the AIFC in Kazakhstan in 2016, as well as the recognition of green finance development as one of the goals in building the AIFC as the region's primary financial centre.

To advance green finance, the AIFC Green Finance Centre was established within the AIFC. The Green Finance Centre's thorough efforts to develop a regulatory and methodological framework for issuing green financial instruments resulted in the introduction of debut green bonds for Kazakhstan and Central Asia in 2020.

The Centre has been crucial in shaping a regulatory framework for Kazakhstan's green finance system. In particular, the Centre has issued the following documents:

– Concept for the implementation and development of instruments and principles of green finance (2017),

– Green Bonds Rules on the AIX (2018),

– Classification (taxonomy) of green projects to be financed through green bonds and green loans (National Green Taxonomy) (2021).

As a result of the work done by the AIFC Green Finance Centre, Kazakhstan has established a legislative and regulatory framework for the operation of the green finance market. Because of its legal status and skills, as well as the country's geographical location, the AIFC has the potential to become a regional green finance hub, contributing to the growth of the green finance sector in Central Asia and Eastern Europe. The National Social Taxonomy aimed to facilitate financing for social projects has been

also developed by the Centre and is planned to be adopted this year.

In addition to green bonds, green loans and social bonds, in 2023 Kazakhstan announced the release of a new sustainable financial instrument – the first sustainability-linked bonds (SLBs) in Central Asia, which will be issued by Almaty Power Plants JSC (APP) in the amount of up to KZT 236, 8 billion (~ USD 535 million) on the AIX. In April 2024, sustainability bonds were issued for the first time in Central Asia by the Development Bank of Kazakhstan.

Kyrgyzstan issued their debut sustainable bonds, specifically, gender bonds, in November 2022. Bank of Asia became the first bank to offer gender bonds to help women entrepreneurs grow their businesses, improve their well-being and lives, achieve gender equality and empower women. Three-year bonds worth KGS 82 million (~ USD 0.9 million) were listed on the Kyrgyz Stock Exchange. The issue's partners included the AIFC Green Finance Centre, UN Women Kyrgyzstan, the Institute for Economic Policy Research of the Kyrgyz Republic, the Kyrgyz Stock Exchange and Senti Financial Company LLC.

Kyrgyzstan issued its first green bonds in June 2023, in cooperation with the AIFC Green Finance Centre. Doscredobank OJSC issued green bonds worth KGS 85 million (~ USD 1 million). These bonds were placed on the Kyrgyz Stock Exchange for three years. The attracted investments are intended to support green initiatives such as the construction of buildings and premises from environmentally friendly materials utilising green and energy-efficient technologies, environmentally friendly transportation and the installation of electric vehicle chargers, among other things.

Tajikistan has ambitious aspirations to develop its green finance market in accordance with the national strategic documents. The Green Economy Development Strategy of the Republic of Tajikistan for 2023–2037 aims to attract green finance at the global markets of green investments by focusing on increasing experience in green bond markets, training specialists to enter global and regional green bond markets, improving legislation in the field of green bonds, and the formation of a clear mechanism for attracting investments, taking into account green economy objectives.

Bank Eskhata OJSC, one of Tajikistan's largest commercial banks, began a joint project with the IFC (International Finance Corporation) to develop and implement the principles of green financing, as a result of which it issued the country's first green bonds worth USD 10 million in February 2024. These bonds represent a significant step towards encouraging sustainable development and addressing climate change in the country. As for sovereign instruments in the field of sustainable development, the Republic of Tajikistan's Ministry of Finance plans to issue sovereign green bonds in 2024 and place them in 2025 as part of the project 'Programme for improving the business environment taking into account climate change and increasing green employment opportunities.'

In contrast to the neighbouring countries, in Uzbekistan the government dominates the domestic sustainable finance market. Uzbekistan is the first country in Central Asia, the CIS (Commonwealth of Independent States) and one of the world's first to issue sovereign bonds for the SDGs. In 2021, Uzbekistan issued USD 235 million in bonds to fund measures to achieve the SDGs (United Nations Development Programme, 2022). In August 2023, Uzpromstroybank issued USD 100 million in

green Eurobonds (SPOT.UZ, 2023). In October 2023, with the support of UNDP (United Nations Development Programme) Uzbekistan issued green sovereign Eurobonds denominated in local currency totalling UZS 4.25 trillion (~ USD 337 million) (UNDP, 2023). On October 25, 2023, the National Green Taxonomy of the Republic of Uzbekistan for green activity classification was developed and approved, which includes defining activity categories and assessing compliance criteria based on the green activity classification. In December 2023, the AIFC Green Finance Centre, in collaboration with the Direct Investment Fund of the Republic of Uzbekistan, actively contributed to the issuance of SAIPRO GROUP LLC's first corporate green bonds in the amount of USD 4 million. In May 2024, the Ministry of Economy and Finance of the Republic of Uzbekistan carried out a second issue of sovereign SDG bonds in the amount of EUR 600 million (~ USD 640 million) for a period of three years (Ministry of Economy and Finance of the Republic of Uzbekistan, 2024).

4 Pathways to filling the gaps in sustainable finance markets of Central Asia

Given the different levels of development of sustainable finance markets, but similar gaps (missing standards, tools and measures), the countries of Central Asia can be offered both general and country-specific recommendations for the development of this segment, which are built around the following key topics (see Table 2):

A) Standardise. Along with investment exchanges in the region, policymakers should strive for the effective development and implementation of local standards for thematic financing that are compatible and aligned with internationally accepted benchmarks, focused not only on mitigation, but adaptation, transition and social criteria as well. The same actors should strive for aligned guidelines for ESG disclosure that would meet investor requirements.

B) Assess. Along with data providers (investment exchanges for capital market, regulators for the banking sector), policymakers should close the gap for reliable regional statistics on sustainable finance, which should be high-quality, granular and timely. The data must be accessible to a broad set of stakeholders.

C) Capacity. Regulators, investment exchanges and financial institutions should consider building educational resources both for retail consumers and the corporate sector, while regulators should also focus on capacity building, targeting the banking sector as well.

D) Encourage. Policymakers should formulate incentives for banks, retails consumers of financial services and project developers to develop new products (green loans, ESG bonds, etc.).

E) Prioritise. Financial institutions should consider developing climate strategies with potential carbon neutrality goals, setting ambitious green finance targets and identifying potential niches and should develop targeted products devoting adequate amounts of financial resources to sustainable finance products.

Table 2. Recommendations for Central Asian countries on developing a sustainable finance market* (✓ indicates which country the recommendation is intended for)

	Recommendation					
A. Supervision and regulation						
1.	Adopt a taxonomy of green (sustainable) finance		✓	✓	✓	
2.	Adopt transition finance standards		✓	✓	✓	✓
3.	Adopt guidelines for thematic bonds (definitions, verification process)			✓	✓	✓
4.	Create thematic segments on exchange platforms			✓	✓	✓
5.	Introduce sustainable finance		✓	✓	✓	✓
6.	ESG disclosure as a requirement for listed companies			✓	✓	✓
7.	Research and analytics on sustainable finance		✓	✓	✓	✓
B. Fiscal policy						
8.	Introduce incentives and support measures for initiators of sustainable projects		✓	✓	✓	✓
9.	Issue sovereign green bonds	✓	✓	✓	✓	
10.	Issue sovereign green sukuk	✓	✓	✓	✓	✓
C. Prudential regulation						
11.	Green capital and reserve requirements	✓	✓	✓	✓	✓
12.	Climate stress testing			✓	✓	✓
D. Buildings and green cities						
13.	Green mortgage schemes		✓	✓	✓	
14.	Issue municipal green bonds	✓	✓	✓	✓	✓
E. Development of sustainable finance mechanisms						
15.	Launch green crowdfunding platforms	✓	✓	✓	✓	✓
16.	Accreditation of local financial institutions with the Green Climate Fund	✓		✓	✓	✓
17.	Establish national and/or regional financing vehicles	✓	✓	✓	✓	✓

Note: These recommendations are prepared on the basis of collected and available information on the presence and absence of certain policies, standards, instruments, etc. in the field of sustainable finance in the countries of Central Asia as of the time of preparation of this study.

Source: Own compilation by authors

4.1 Supervision and regulation

4.1.1 Recommendation 1: Adopt a taxonomy of green (sustainable) finance – Kyrgyzstan, Tajikistan, Turkmenistan

A taxonomy of green (sustainable) projects as a classification is needed to provide a common understanding and approach to the identification, development and financing of green (sustainable) projects, as well as to bolster investor confidence and prevent 'green camouflage' – a situation where projects without environmental benefits are presented as green. A taxonomy also provides a framework for disclosure and reporting, as well as for the use of economic incentives, such as interest rate subsidies and guarantees.

4.1.2 Recommendation 2: Adopt transition finance standards - Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

The transition to clean energy in the short and medium term is not always possible due to various factors, especially in hard-to-abate sectors. Despite this, it is still necessary to incentivise businesses that are trying to reduce their negative impact on the environment, for example by reducing greenhouse gas emissions. To achieve this, it is recommended to adopt standards in the field of transition finance. The adoption of transition finance standards will provide clear criteria for attracting financing for projects that do not fall under the criteria of green projects, but will reduce the negative impact on the environment. For example, according to the latest amendments to the National Green Taxonomy of Kazakhstan, projects such as the production of electricity and heat from gas and replacement of fuel, the production of equipment for nuclear energy, and the construction and operation of nuclear power plants may be eligible for transition finance, subject to the established taxonomy criteria.

4.1.3 Recommendation 3: Adopt guidelines for thematic bonds (definitions, verification process) - Tajikistan, Turkmenistan, Uzbekistan

Supervisory authorities can establish guidelines and recommendations for thematic instruments (green, social, sustainability and sustainability-linked bonds). These can help standardise the local market, which reduces due diligence costs for investors and promotes transparency efforts. Aligning local guidelines with ICMA (International Capital Market Association) and the Climate Bonds standard will ensure consistency with international markets and local issuances meeting investor expectations. Such guidelines may help jumpstart the development of local green bond markets. For example, in Kazakhstan's national legislation, definitions of green finance instruments were first established in the Environmental Code in 2021, and subsequently amendments were made to the Securities Market Law to define all types of thematic bonds, as well as their features, including external review aspects.

4.1.4 Recommendation 4: Create thematic segments on exchange platforms - Tajikistan, Turkmenistan, Uzbekistan

Regulators can work with stock exchanges to create green/sustainable segments to increase the visibility of sustainable finance instruments. Listing requirements in specified segments also provide investors with certainty about the issue by reducing due diligence requirements. According to the Sustainable Stock Exchanges Initiative (SSE), 41% of SSE member exchanges have ESG segments, including the stock exchanges in Kazakhstan and Kyrgyzstan.

4.1.5 Recommendation 5: Introduce sustainable finance reporting - Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

Financial regulators in the countries of the region are already taking measures to introduce ESG principles into the activities of financial institutions, in particular introducing voluntary

and mandatory ESG reporting for banks. As part of this work, it is necessary to note the importance of introducing accounting for green loans by banks. Amendments to the resolution of the National Bank of the Republic of Kazakhstan in December 2023 on bank reporting forms introduced a 'Sustainability Project Attribute' into the corresponding reporting forms for banks, in particular a value under code ESG001 'Green loans.' This value must be indicated in the *Report on Provisions and Risk Assessment*, starting from January 2024 for all loans that comply with the National Green Taxonomy of Kazakhstan.

4.1.6 Recommendation 6: ESG disclosure as a requirement for listed companies – Tajikistan, Turkmenistan, Uzbekistan

Stock exchange listing requirements ensure that investors are properly informed before making an investment. The regulator, as well as the stock market itself, can ensure that listing requirements include ESG reporting. According to SSE data, 31% of exchanges have ESG reporting as a listing requirement. Among these platforms are Kazakhstan's KASE and the Kyrgyz Stock Exchange. In particular, according to the rules of the Kyrgyz Stock Exchange, these requirements apply to issuers of sustainable development bonds of categories A and B.

4.1.7 Recommendation 7: Research and analytics on sustainable finance – Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

Research and analysis can play an important role in the development of sustainable finance, for example, research carried out by the G20 Working Group on Sustainable Finance has provided the basis for many concepts, including the concept of transition finance. In this regard, institutionalisation in the field of sustainable finance is an important aspect for market development. Research can also play an important role in the development of national standards.

4.2 Fiscal policy

4.2.1 Recommendation 8: Introduce incentives and support measures for initiators of sustainable projects – Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan

The introduction of a system of incentives and support measures for potential issuers contributes to more active issuance of bonds and loans to finance sustainable development projects. An example of such is the subsidised interest rates on green loans and the coupon rates on green bonds introduced in Kazakhstan. At the same time, these incentives should take into account the additional transaction costs inherent in sustainable financial instruments and create more attractive conditions for raising money for sustainable projects compared to projects in other sectors of the economy.

4.2.2 Recommendation 9: Issue sovereign green bonds – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan

The general and main recommendation for most countries in the region is to issue sovereign green bonds to stimulate local markets in order to finance projects contributing to the state's goals of transitioning to a green economy and achieving carbon neutrality. This mechanism aims to actively attract investors whose mandate includes responsible investment. The case of Uzbekistan is illustrative and can serve as an example for governments of other Central Asian countries that need to attract external financing to achieve low-carbon economic development goals.

4.2.3 Recommendation 10: Issue sovereign green sukuk – all Central Asian countries

For all countries in the region, the symbiosis of green and Islamic financing represents great potential, since the majority of the region's population professes Islam, which demonstrates high potential for development, for example, of such an instrument

as green sukuk,[52] which combines the principles of Islamic and ESG financing.

4.3 Prudential regulation

4.3.1 Recommendation 11: Green capital and reserve requirements – all Central Asian countries

In order to encourage the banking sector to issue loans for sustainable projects, it is recommended that central banks in the region consider the possibility of easing macroprudential regulation, namely central banks can reduce risk weights and reserve requirements, for example on green loans. This will provide an incentive for commercial banks to issue more green loans. For example, the central bank of Hungary has reduced reserve requirements for green loans: Hungarian banks are entitled to significantly reduced capital requirements for loans used for the purchase and construction of energy efficient real estate.

4.3.2 Recommendation 12: Climate stress testing – Tajikistan, Turkmenistan, Uzbekistan

Climate stress testing (conducted in a top-down approach by regulators or a bottom-up approach by individual financial institutions) is an important tool for identifying sources of economic vulnerability to climate risks. It could also encourage financial institutions to take action to improve climate resilience and could form the basis for targeted monetary and prudential policies. Regulators can use the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) scenarios to develop national scenarios and stress tests. These six scenarios

[52] Sukuk is the Arabic name for financial certificates (https://en.wikipedia.org/wiki/Financial_instrument), also commonly referred to as "sharia compliant" (https://en.wikipedia.org/wiki/Sharia) bonds (https://en.wikipedia.org/wiki/Bond_(finance)). More information on sukuk can be found here: https://en.wikipedia.org/wiki/Sukuk

provide different 30-year projections of climate change mitigation policies and physical climate risks.

4.4 Buildings and green cities

4.4.1 Recommendation 13: Green mortgage schemes - Kyrgyzstan, Tajikistan, Turkmenistan

Banks can be encouraged to provide green mortgages through preferential green capital treatment and reserve requirements (see section C). It should be noted that there is a high potential for reducing the carbon intensity of economies through the introduction of more energy-efficient housing.

4.4.2 Recommendation 14: Issue municipal green bonds - all Central Asian countries

Similar to sovereign green bonds, municipal bonds can serve as an additional tool to raise financing for green projects, but at the level of cities, counties, etc. Such bonds are used by city authorities to obtain funds for projects to develop environmentally-friendly public transport and green buildings, improve energy efficiency and develop water treatment facilities, as well as to refinance existing green projects.

4.5 Development of sustainable finance mechanisms

4.5.1 Recommendation 15: Launch green crowdfunding platforms - all Central Asian countries

Green crowdfunding is an innovative and complementary financing tool for green projects, especially green energy projects, which has been gaining popularity around the world in recent years. Crowdfunding provides an opportunity for citizens to integrate concerns about the environment and climate change into their investment portfolio. This is a great way for retail investors to diversify their portfolio and do their part in the fight against climate change. In particular, green crowdfunding platforms for financing renewable energy projects are gaining

popularity around the world. For example, since its creation in 2010, the Dutch platform Windcentrale has raised more than EUR 14.3 million, making the platform the largest in the field of crowdfunding in the field of renewable energy sources. The money invested is used to purchase wind turbines, generating energy credits that the investors can use to cover their monthly energy bills. Such platforms can especially help attract financing for small-scale renewable energy projects (Habitatpoint, 2021).

4.5.2 Recommendation 16: Accreditation of local financial institutions with the Green Climate Fund (GFC) – Kazakhstan, Tajikistan, Turkmenistan, Uzbekistan

To expand access to international climate finance, countries in the region need to step up efforts to accredit at least one local financial institution to the Green Climate Fund. As previously noted, at present the main partners of the GCF in the countries of Central Asia are international development banks. Today, only one of the national financial institutions of the Central Asian countries (ARIS, Kyrgyzstan) is accredited with the GCF.

4.5.3 Recommendation 17: Establish national and/or regional sustainable financing vehicles – all Central Asian countries

Given the enormous amount of green investment required in the context of the interdependence of water and energy systems, as well as the challenges in transforming energy-intensive economies, the next step in the development of green finance in the region would be to discuss the idea of creating a regional green finance vehicle. A regional financing vehicle provides greater opportunities to access international climate funds and pools of public, private and bilateral funding sources and can serve as a regional focal point for international investors and has the potential to attract more international attention through a broader offering of environmental and climate projects. For example, the mechanism could be created in the form of a Regional Climate Fund or a fund of funds for Central Asian countries in partnership

with international climate funds (GCF, Adaptation Fund and others), institutional investors, donors (including governments), international financial institutions and multilateral development banks.

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