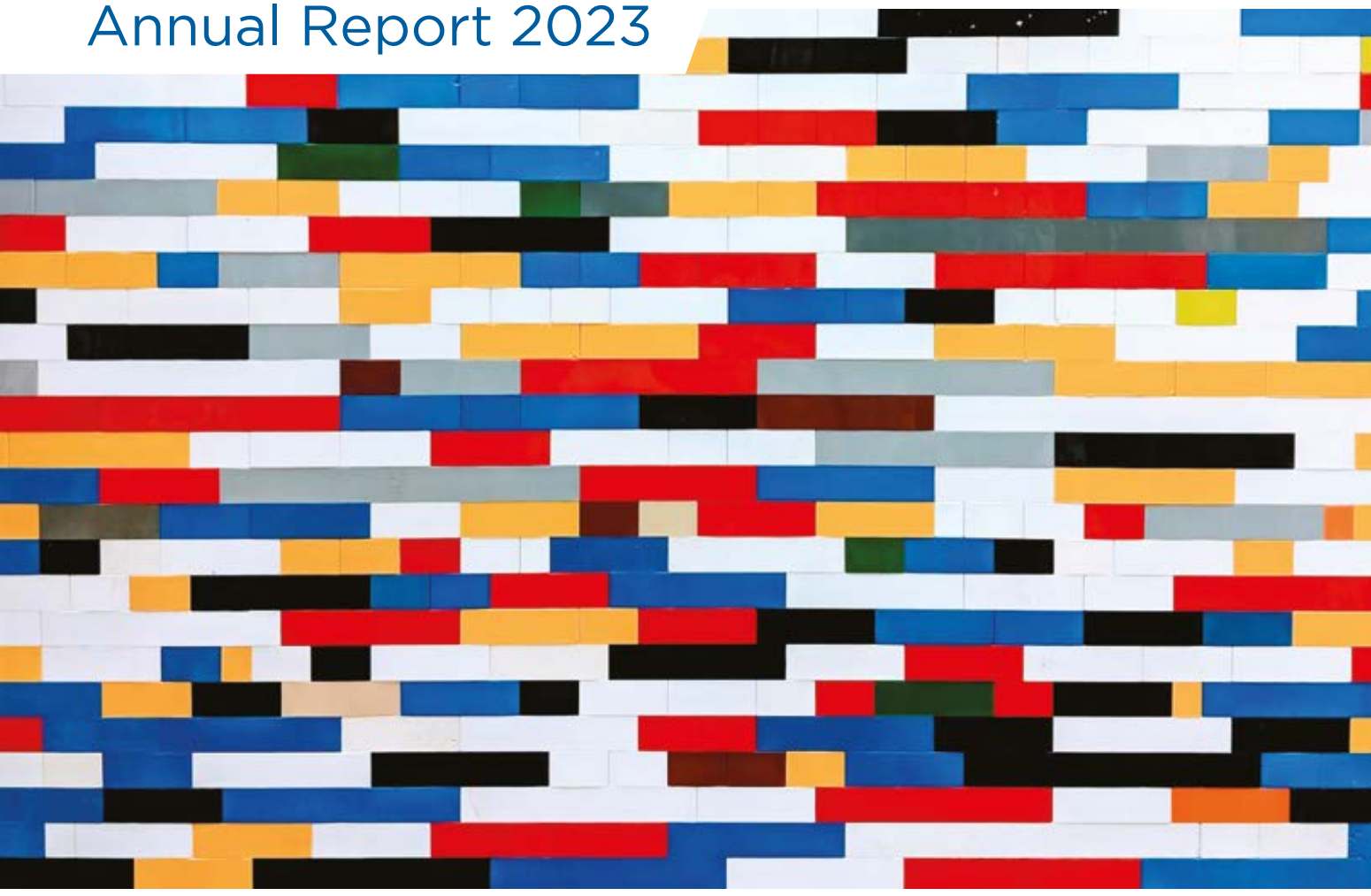
GREEK NATIONAL PRODUCTIVITY BOARD

Annual Report 2023



Challenges and Policies for Sustainable Development

GREEK NATIONAL PRODUCTIVITY BOARD (NPB)

CENTRE OF PLANNING AND ECONOMIC RESEARCH (KEPE)

Greek National Productivity Board Annual Report 2023

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Contributions

This report was prepared by the Centre of Planning and Economic Research which acts as the National Productivity Board (NPB) of Greece, under the coordination and scientific editing of its Steering Committee.

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Foreword

Panagiotis Liargovas

The Centre of Planning and Economic Research (KEPE) assumed the function of the Greek National Productivity Board in April 2019.[1] Even though this is a new role for KEPE, the Centre has a long history of research in matters concerning the Greek economy and its productivity. Indeed, since its establishment in 1959, headed by Andreas G. Papandreou, who would later become the Prime Minister of Greece, KEPE has kept a close eye on the Greek economy, producing studies and reports that have helped economic policy makers in their decisions and contributed to the scientific study of the Greek economy. Today, with 30 researchers on staff, KEPE remains the largest research institute on economic matters in Greece. KEPE is mostly financed by the Greek Government, but retains its independence. Researchers are hired with open calls for specific positions and their recruitment and promotion is decided by independent committees. We have researchers specialising in different fields of research and sectors of the Greek economy. This expertise has been put to use in producing the fifth productivity and competitiveness report at hand.

Apart from drawing up the annual report on productivity, KEPE has already published a number of studies and reports that deal directly with issues pertaining to productivity. As a National Productivity Board, KEPE is in the process of producing a number of more specialised studies published in the newly established series Productivity Reviews.

The findings of this annual report stress that the Greek economy has returned to normality as it has fully reversed the impact of the COVID-19 pandemic and has improved its position in several competitiveness indicators. During 2022, labour productivity per hour worked increased by 0.3%, and labour productivity per person employed increased by 2.0%, whereas TFP increased by 2.9% (using hours worked) and by 3.8% (using employment). Nevertheless, the gaps between the labour productivity of the Greek economy and the average labour productivity in the EA19 and the EU27 are considerable and persistent, with no signs of convergence.

Despite the positive growth prospects, the GDP growth in 2022 was mainly driven by private consumption and to a lesser extent by investment. Besides, the deterioration in current accounts (deficit of

1. Law 4605/2019, Art. 37, Gov. Gaz. A΄ 52/1.4.2019.

9.7% over GDP in 2022) contributed to -6.2% of GDP growth, as imports significantly outperformed exports. The intense core-periphery disparities also remain, as the region of Attiki continues to perform significantly better than the other regions of the country in all sub-indices and in almost all pillars of the Regional Competitiveness Index, and it is the only transition region in Greece, while all the other regions are less developed regions. At the same time, the continuation of the war in Ukraine, the surge in energy prices, persistent inflation, the increased cost of borrowing for businesses and households, adverse demographic changes, technological backwardness and the more frequent natural disasters due to climate change pose additional challenges to the Greek economy.

To avoid the negative consequences of high inflation and interest rates, the Greek government can employ several policies, strategies and plans which boost growth while ensuring the economic, social and environmental sustainability. These include, among others: (a) the revision of the Recovery and Resilience Plan (RRP) to ensure a more balanced emphasis across sectors, particularly those that bolster productivity without compromising on environmental goals, (b) incentives for digital transformation of Greek firms which need to accelerate their efforts towards a special focus on Industry 4.0 technologies and (c) the implementation of a wide range of policies that reduce inequalities, while, at the same time, supporting productivity.

We hope that this report, which takes a long view of examining the performance of the Greek economy, will provide a useful overview of the current situation and will indicate the necessary reforms to accompany the growth path of the economy.

Professor Panagiotis Liargovas
Scientific Director, National Productivity Board
Chairman of the Board and Scientific Director,
Centre of Planning and Economic Research (KEPE)

Preface

Theodore Tsekeris

The global environment is continuously changing, subject to asymmetric geopolitical risks, geoeconomic fragmentation, supply chain disruptions, macroeconomic volatility, fiscal fragilities, demographic challenges, technological transformations and climate vulnerability involving several extreme weather events. In this environment and after having fully recovered from the COVID-19 pandemic shock, the Greek economy seems to be returning to normality, trying to address some of its significant and persistent structural imbalances and ameliorating its cost competitiveness in Europe.

In this process, several prompt and effective actions and reforms should take place in order for the country to change its production model, to become less dependent on imports of goods, to be more self-sufficient in terms of goods, and to be more extroverted in the trade balance to improve the current accounts. In this respect, a more comprehensive and strategic consideration of the holistic investment plan is required to achieve a more balanced and efficient allocation of resources among sectors, in a way that improves productivity without compromising on environmental goals.

Moreover, significant steps need to be taken to expedite the digital transformation of the Greek economy and society and to facilitate the actual contribution of Industry 4.0 technologies to economic, social, environmental and energy sustainability. Among others, Artificial Intelligence (AI) and, especially, generative AI, is expected to have a remarkable impact on productivity, but actions should also be taken to mitigate the (societal, safety, security, environmental and other) risks and downsides of AI.

At the same time, policies for combatting social inequalities and supporting territorial cohesion and regional convergence are necessary to ensure inclusive, sustainable growth. Finally, an extension of bank credit is needed, through expanding strategic partnerships and exploring alternative financing avenues, in order to sustain the higher levels of both total factor productivity and GDP growth.

Theodore Tsekeris
Head of the Steering Committee
National Productivity Board of Greece

Executive Summary

The Greek economy has fully recovered from the effects of the COVID-19 pandemic. Moreover, the initial inflationary pressures, which were caused by a multitude of internal and external factors, have subsided. Therefore, Greece is currently geared up not only for normal growth, but possibly for a takeoff, under the condition that pent up investment and demand –after more than a decade of crisis and slow growth– are brought forward. The total factor productivity (TFP) growth of the Greek economy has reached the corresponding growth of the EA19 and the EU27, since between the year before the pandemic (2019) and the current year (2023), it increased by about three times more than the EA19 and the EU27 average.

However, the persistent gap between the labour productivity of the Greek economy and the European one, both in terms of persons employed and hours worked, remained substantially the same during 2019-2023. Namely, the Greek labour productivity in persons employed is about 61% of the EU27 average and 55% of the EA19 average. Correspondingly, the Greek labour productivity in hours worked is about 49% of the EU27 average and 43% of the EA19 average.

Crucial for the materialisation of the expected growth dynamics of the Greek economy are, on the one hand, the increase in labour utilisation, a key factor considering the medium- to long-term adverse effects of population aging, and, on the other hand, the significant increase in fixed capital investment, particularly, in the business and high-technology sector of the economy. Regarding the Greek Recovery and Resilience Plan (RRP), its impact is expected to yield significant economic output (13.7 billion euro) and employment opportunities (about 400,000 jobs), namely, a growth of 8.3% in output and 10.5% in employment, compared to Greece's 2020 GDP and employment levels.

Nevertheless, our analysis suggests that the RRP may not be entirely aligned with Greece's long-term strategic objectives, due to the overreliance on a limited set of sectors, mostly Construction, which cannot sufficiently support the broader goals of sustainable productivity, reduced dependence on imports and substantial limitation of CO2 emissions. For this reason, a revision of RRP is suggested to boost productivity in a robust way and without compromising on environmental goals. It is also noted that Construction was the sector that experienced the highest labour productivity growth in the Greek economy during the period 2020-2022.

Recent developments stress the amelioration of the cost/price competitive position of the Greek economy relative to the EA19. Specifically, the Real Effective Exchange Rate (REER) based on the Consumer Price Index (CPI) slightly decreased in 2022 for fourth consecutive year. The REER based on the Unit Labour Cost in the total economy (ULCT) also decreased in 2022 for second consecutive year, reaching its lowest point during 2010-2022. The Unit Labour Cost (ULC) also decreased in 2022 for second consecutive year, while it was increased in the EA19 and the EU27. The relative ULC decreased by 1.7 p.p. in 2022, compared to 2021. However, the wars in Ukraine and the Middle East, the surge in energy prices, persistent inflation, the increased cost of borrowing for businesses and households, the deterioration in the current account balance,

demographic change, technological backwardness and the more frequent natural disasters due to climate change pose additional challenges to the Greek economy. Besides, as reflects the Regional Competitiveness Index (RCI), all the Greek regions reside at the end of the scale, with persistent core-periphery difference (between the region of Attiki and the rest of the regions).

Furthermore, the report stresses that Greek firms need to accelerate their efforts towards digital transformation with a special focus on Industry 4.0 technologies. For this purpose, several actions are proposed, including the acceleration of knowledge transfer, cooperation and partnerships between business and universities, the transformation of AI publications into high impact AI projects, AI software and applications through venture capital funding schemes. Moreover, Greek firms should take actions to manage the environmental footprint associated with the use of Information and Communication Technologies (ICT) and reinforce the circular economy.

A wide range of policies should also be considered to reduce inequalities while increasing productivity growth. Such policies may encompass the acquisition and development of skills, labour market reforms, robust social protection measures, affordable financing of small-scale entrepreneurship and support of technology transfer and inter-firm linkages for export promotion. Finally, the extension of bank credit can help to sustain higher levels of both TFP and GDP growth.

1. Introduction

1.1. Global challenges and productivity developments

Countries nowadays are operating in a more fragile environment and with increased uncertainty. Amongst others, these conditions are driven by different forces involving geopolitical risks, geoeconomic fragmentation, trade tensions and the West–China disconnect. In turn, this fragmentation could strain the global financial safety net and lead to greater macroeconomic volatility, more severe crises and greater pressures on public finance (Aiyar et al., 2023).

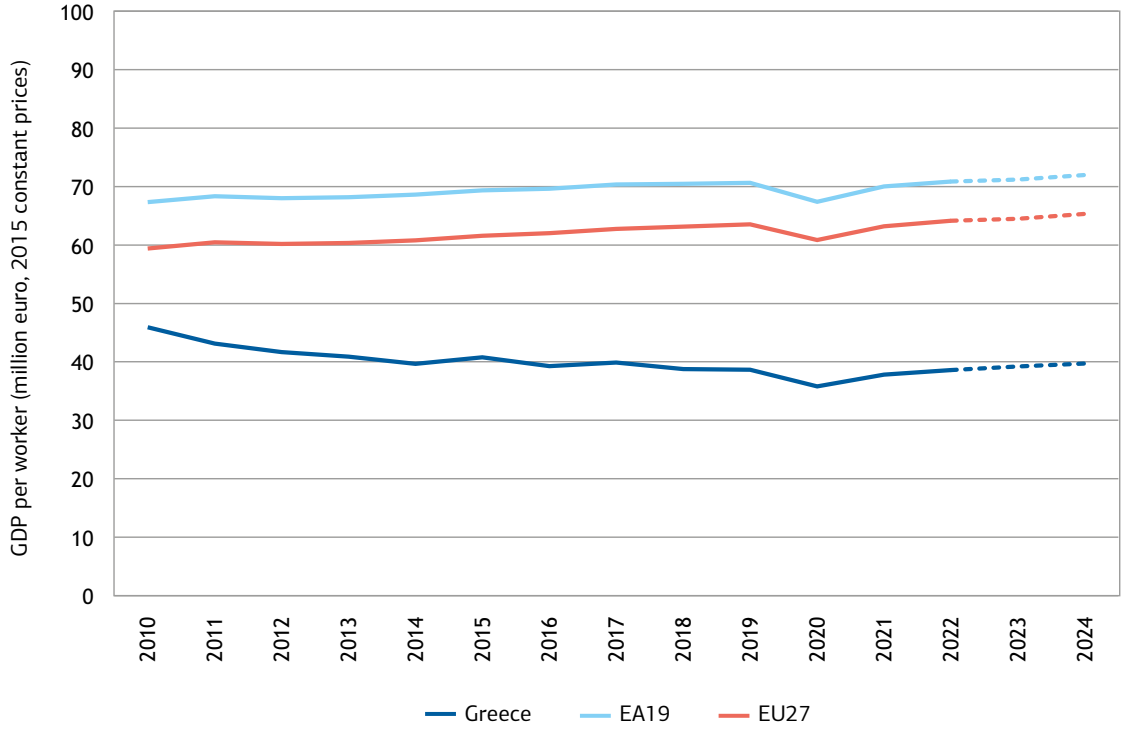
In addition to the fiscal resources used to combat the adverse impacts of the COVID-19 pandemic and the rising inflation and energy costs, further fiscal resources are now spent to deal with the effects of several extreme weather events (extreme heat, fires, droughts, floods, storms). These events tend to appear more often, as a result of climate change, influencing the economy and society. In turn, the severe GDP losses from climate shocks amplify existing fragilities in fiscal conditions (Akanbi, Gbohoui, and Lam, 2023). Hence, macro-prudential and adaptation policies should be properly designed and implemented to facilitate prompt and effective responses to climate shocks and enhance climate resilience.

In Greece, the adverse effects of the pandemic in the economy have been fully reversed, and the economy has returned to normal conditions. The Greek economy has improved its competitiveness in several critical indicators and its overall score in the Regional Competitiveness Index and in two sub-indices (basic and innovation) in 2022, compared to 2019. Nevertheless, Attiki remains the only transition region in Greece, while all other regions are less developed. Moreover, the challenges posed by climate change, technological advancements, demographic changes, geopolitical conflicts, and the transformation of globalisation may have asymmetric implications across regions within a country. The recent crises of the COVID-19 pandemic and the war in Ukraine have underscored and exacerbated pre-existing territorial inequalities.

During the year 2022, several improvements in economic aggregates, productivity indices and competitiveness indicators were observed in Greece (for more details, see Sections 2 and 3). A slight productivity growth was also recorded in the EU27. More specifically, in 2022, the labour productivity of the Greek economy, as expressed by the GDP per worker (person employed), experienced a growth of about 2%, compared to the previous year (2021), and almost fully recovered its losses due to the COVID-19 pandemic (Figure 1.1). The growth of labour productivity was milder in terms of persons employed in the EA19 and the EU27, compared to the previous year (by 1.2% and 1.5%, respectively). Moreover, Greek labour productivity in terms of persons employed is expected to grow faster during the period 2022-2024, i.e., by 2.8%, than the corresponding EA19 and EU27 average (by 1.6% and 1.8%, respectively).

Nonetheless, it is stressed that no signs of labour productivity convergence of the Greek economy with the corresponding EA19 and EU27 averages are observed. In particular, the labour productivity gap between the Greek economy and the European economy, in terms of persons employed, substantially remained the same during 2019-2023, as it still corresponds to 61% of the EU27 average and 55% of the EA19 average.

Figure 1.1 Labour productivity in GDP (million euro, constant prices) per worker in Greece, the EA19 and the EU27 during 2010-2022, and 2023-2024 forecasts

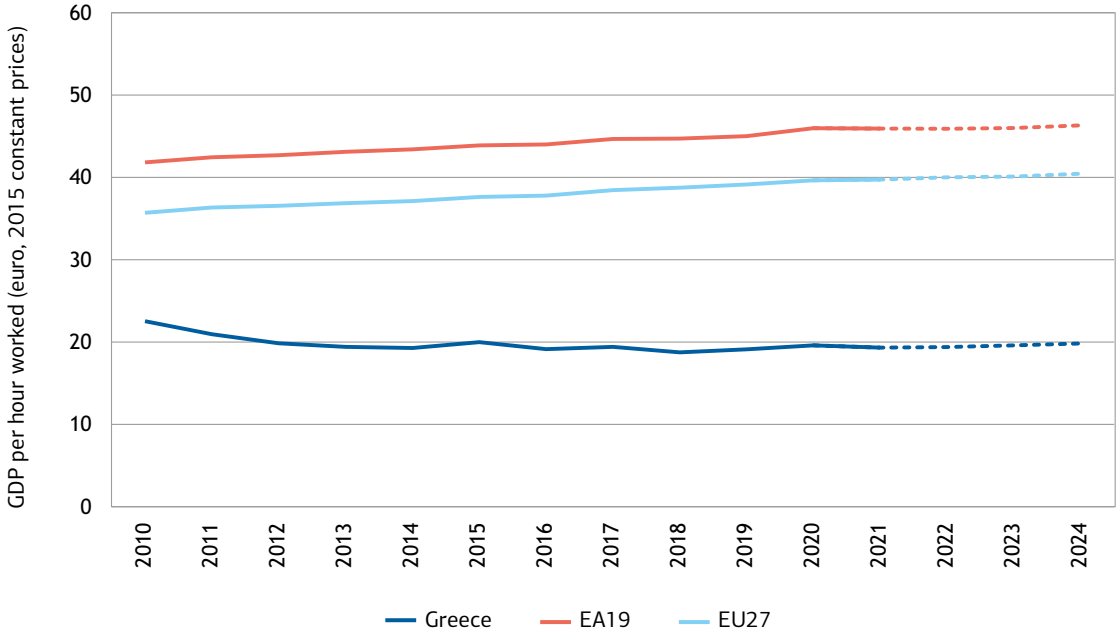


Source: AMECO and own processing.

Regarding labour productivity as expressed by the GDP per hour worked, it experienced a much lower growth, by about 0.3% between 2021-2022. This limited growth is smaller than the corresponding EU27 average (0.65%), but higher than the zero growth of the corresponding EA19 (Figure 1.2). Greek labour productivity in terms of hours worked is also expected to grow faster during the period 2022-2024, i.e., by 2.2%, than the corresponding EA19 and EU27 average (by 0.9% and 1.1%, respectively). The labour productivity gap between the Greek economy and the European economy, in terms of hours worked, is somewhat smaller than that in terms of persons employed. Specifically, Greek labour productivity, as expressed by the GDP per hour worked, is about 49% of the EU27 average and 43% of the EA19 average.

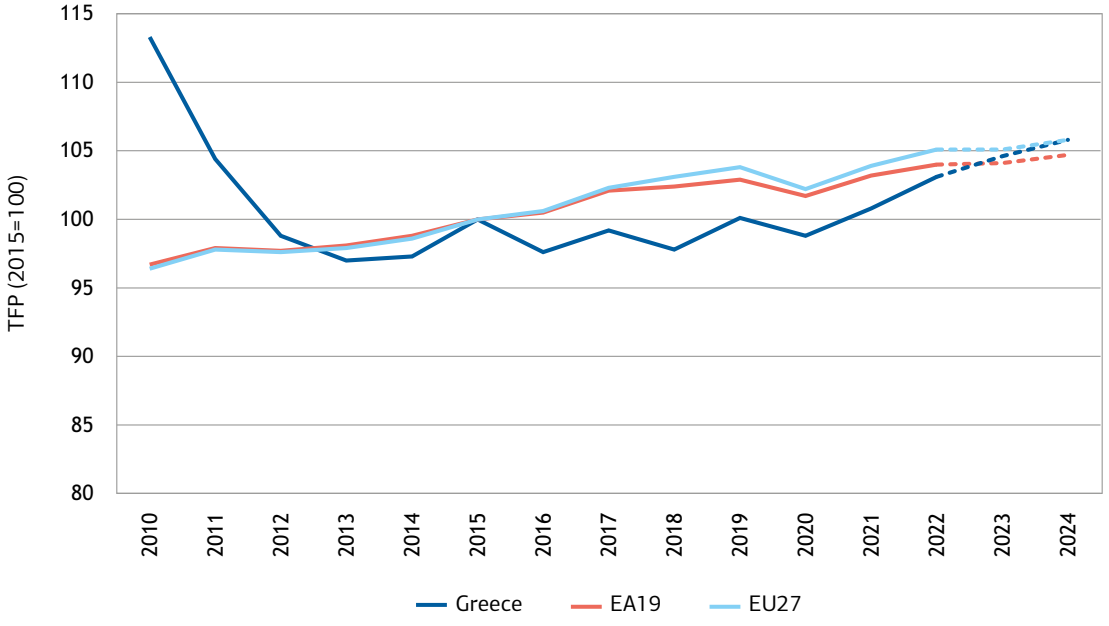
As far as the TFP of the Greek economy is concerned, its performance, in terms of its growth during 2021-2022, as well as during the period 2019-2023, is higher than that of labour productivity, both in terms of persons employed and hours worked. More specifically, the Greek economy's TFP index grew by 2.3% in 2022, compared to the previous year (2021) (Figure 1.3). The corresponding growth was equal to 0.8% in the EA19 and 1.2% in the EU27. Furthermore, the Greek economy's TFP index is expected to grow by 2.6% between 2022-2024, i.e., much faster than the corresponding EA19 and EU27 averages (both by 0.7%).

Figure 1.2 Labour productivity in GDP (euro, constant prices) per hours worked in Greece, the EA19 and the EU27 during 2010-2022 and 2023-2024 forecasts



Source: AMECO and own processing.

Figure 1.3 TFP evolution in Greece, the EA19 and the EU27 during 2010-2022, and 2023-2024 forecasts (2015=100)



Source: AMECO and own processing.

1.2. The scope of the annual report for 2023

This annual report is composed of three major parts. The first one (Section 2) describes, through suitable models, measures and indices, how the Greek economy fully recovered from the COVID-19 pandemic shock and mildly increased its productivity, compared to the previous year and in relation to the productivity growth of the EA19 and the EU27. Together with the recent macroeconomic developments, projections of the country's economic performance during the current and the next year are discussed. The analysis of productivity growth is based on the decompositions of output per capita, labour productivity and labour utilisation, as well as on the measurement of the contributions of broad economic sectors to labour productivity growth. Particular emphasis is given to the impacts of demographics, total capital stock and its categories, and public investments originating from the Greek Recovery and Resilience Plan.

The second part (Section 3) reports the main developments in public finance and the current accounts of the Greek economy, and recent improvements in cost/price competitiveness indices and the regional competitiveness and relevant gaps of the region of Attiki with the rest of the Greek regions. The remaining part of Section 3 mostly focuses on issues of digitisation and Artificial Intelligence (AI). Specifically, it presents main challenges and reforms for the digitalisation of Greek businesses, competitiveness indicators for digitisation and AI, and developments in the adoption of Industry 4.0 technologies by Greek firms, including the need to take proper actions for diminishing the environmental footprint of Information and Communication Technologies (ICT).

It should be stressed that these issues are quite timely and important, given recent policy initiatives during 2023 towards a global governance of AI processes. In particular, the G7 countries agreed to cooperate and establish common principles on AI governance, while the European Commission published a draft of guiding principles developed by the G7 under the Hiroshima Artificial Intelligence process for the public, addressing issues of the safety, security and trustworthiness of AI systems. Also, the Cyberspace Administration of China published its Global AI Governance Initiative (GAIGI), which deals with various AI governance areas, such as transparency, accountability, safety, security and trustworthiness, similar to the G7 principles. Despite the significantly different approaches for handling several AI issues among countries, these initiatives underline the need to promote a more sustainable and inclusive growth through prioritising advanced AI systems to treat the greatest global challenges, such as the climate crisis, public health and education, while mitigating societal, safety and security risks through promoting interoperability and investment in effective mitigation measures.

Regarding the third part (Section 4) of this report, two main thematic challenges are discussed with horizontal productivity/competitiveness implications. The first one relates to the relationship between income inequalities and productivity growth, while the second one concerns the relationship between bank credit, financial stability and the TFP and economic growth. Section 5 summarises and concludes, offering useful policy implications for boosting investment to support a more sustainable and resilient growth, maintaining macroeconomic stability and competitiveness, fostering digitisation and Industry 4.0 technologies, strengthening the financial system and treating economic disparities.

2. Macroeconomic Environment and Productivity Developments

2.1. Macroeconomic environment

During 2022, the Greek economy expanded at a pace of 5.9% as the V-shaped recovery from the effects of the COVID-19 pandemic continued. Currently, the level of output relative to 2019, the last year before the effects of the pandemic were felt in the economy, is consistent with the long-run target of a 2% change in output per year. Thus, as a preliminary conclusion, the adverse effects of the pandemic in the economy have been fully reversed, and the economy has returned to normal conditions. This assumption can also be verified from the transitory characteristics of inflationary pressures, that, after rising to 12.1% in June 2022, have fallen to 1.8% by June 2023 and from the continued decline in the unemployment rate that in June 2023 stood at 11.1%. Moreover, the robustness of the recovery process can also be verified by the fact that its main drivers have been private consumption and investment, with the latter in particular providing a significant and sustained boost in the economy during the last 8 quarters for the first time since 2008.

Despite the significant improvement of macroeconomic conditions, several headwinds, both actual and potential, remain, leaving no room for complacency. First, the significant tightening of monetary policy as a response to inflationary pressures has raised the cost of borrowing for businesses and households and will have in the medium term a significant impact on income. Second, directly related to changes in monetary policy is the issue of the financial stability of major banking institutions, as indicated by bank failures in the USA and Switzerland. Third, the continuation of the war in Ukraine, beyond its nature as an existential and direct geopolitical threat, also has a number of direct adverse economic consequences mainly, through increased uncertainty and, secondarily, via its effect on commodity and energy markets. Fourth, the deterioration in the current account balance is significant, having reached a deficit of 9.7% over GDP in 2022. This is a direct result of the deterioration in the external balance of goods and services. This deterioration was caused by such a significant deficit in the net imports of goods that the net surplus in the exports of services was not sufficient to cover it. The latter fact reflects significant remaining structural weaknesses in the Greek economy.

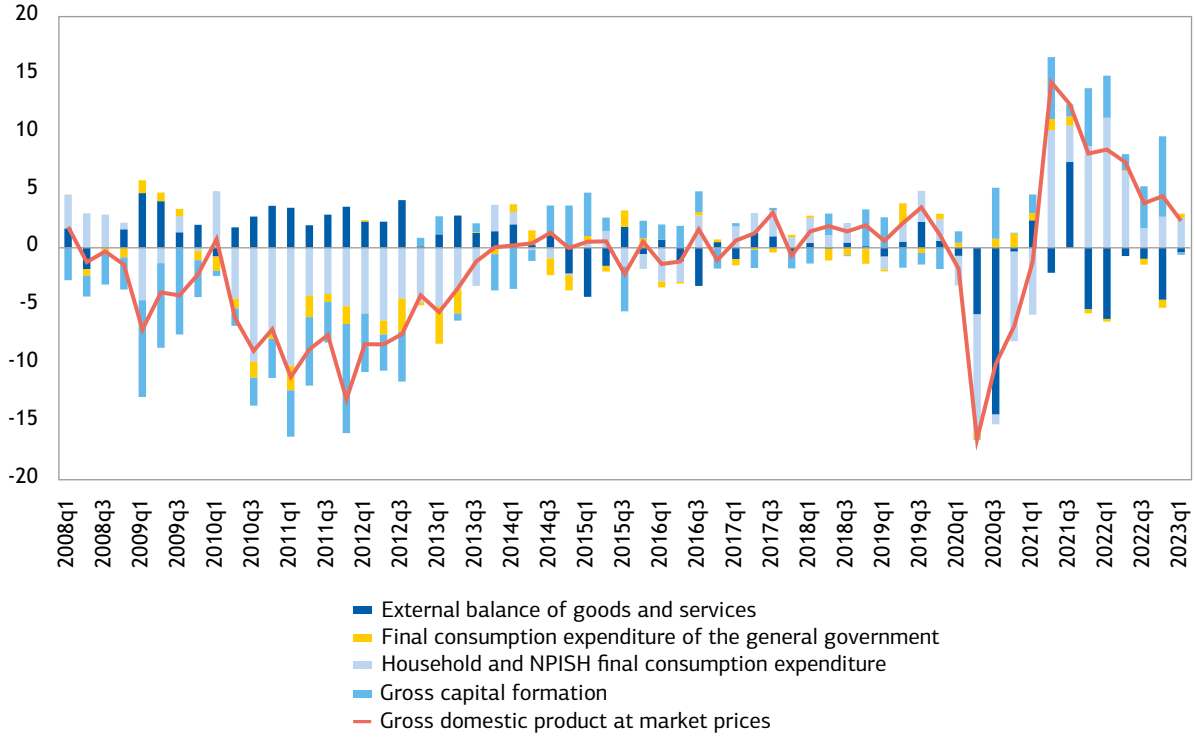
It is important to note that during 2022, as the economy returned to normal conditions, public finances also improved drastically (see also Section 3.1). In particular, net borrowing by the general government in 2022 stood at 4% of GDP, after having deteriorated to 10.7% in 2022, with the primary balance expected to return to surplus during 2023. The recovery of public finances is the result of the rapid decline in general government expenditure, from 59.7% of GDP in 2020 (up from 47.7% in 2019) to 50.3% in 2023, and of the stability in public revenue, from 48.9% of GDP in 2020 to 47.9% in 2023. As a result, gross public debt declined from 212% of GDP in 2020 to 166% in 2023, and according to IMF projections, it is expected to decline to 143% by 2028. As a

consequence, Greece is currently one step away from regaining an investment-grade rating after more than 12 years.

Therefore, in conclusion, private capital accumulation, stimulated in part by the expectations formulated by the implementation of the RRF (Recovery and Resilience Facility) and by multiplier effects from the fiscal stimulus in response to the effects of the pandemic, has been the major factor behind the significant turnaround in the Greek economy after COVID-19. The sound fiscal position of the general government, achieved via the prompt and successful withdrawal of stimulus spending, resulting in a major adjustment in the fiscal position of the public sector, has provided fundamental stability to this process. Thus, despite the number of headwinds described, the Greek economy appears to be well positioned to enter a virtuous circle of growth and expansion.

Turning to a more detailed examination of the factors contributing to GDP growth during the last year, starting from the first quarter of 2022, we find that GDP grew at a rate of 8.5% per year (Figure 2.1.1). On the one hand, this increase can be attributed mainly to the strong increase in private final consumption expenditure that contributed 11.3% and, secondarily, to the significant increase in investment that contributed 3.7%. On the other hand, general government consumption contributed negatively, as it contracted by 0.2%.The external balance also had a significant negative effect, contributing a negative 6.2% to GDP growth, as imports significantly outperformed exports, with the former reducing output by 8.3% and the latter expanding it by 2.1%.

Figure 2.1.1 Contributions to GDP growth



Source: Eurostat.

During the second quarter of 2022, growth decelerated to 7.4%, with private consumption contributing 11.3% and investment contributing 1.4% to GDP growth. Moreover, public consumption also directly contributed to GDP growth by a marginal 0.1%. A significant increase in exports, which contributed 6.3% to GDP growth, coupled with a small decline in the effect of imports, affecting GDP by 7%, resulted in a significant narrowing of the trade balance, the latter contributing to GDP growth by a negative 0.7%.

During the third quarter of 2022, the deceleration in economic growth continued, as GDP grew by 3.9%. Critically, the increase in GDP during this quarter came mainly as the result of a significant increase in investment, which contributed to GDP growth by 3.6%, and, secondarily, by the increase in private consumption that contributed to GDP by 1.7%. Government spending had again a marginally negative impact, reducing GDP by 0.5%, whereas net exports also reduced GDP by 1%, with exports contributing a positive 1.1% and imports a negative 2.1%.

During the fourth quarter of 2022, economic activity picked up as GDP grew at a pace of 4.5%. This came as the result of a significant increase in investment activity, which contributed to GDP growth by 7%, and of private consumption that impacted GDP by 2.7%. General government spending had a negative impact of 0.7%, while net exports deteriorated significantly, by 4.5%, as imports negatively impacted GDP by 3.2% and exports positively by 1.3%.

Finally, during the first quarter of 2023, economic activity increased at a reduced pace, by 2.3%, a result of the general normalisation of economic conditions, albeit still higher than the EA average. This was the result of private consumption contributing 2.6% to GDP growth, with the general government contributing an additional 0.4%. On the contrary, in this quarter, investment activity contributed negatively by 0.2%, mainly due to changes in inventories, and net exports also contributed negatively by 0.4%.

It is important to note that, in the case of Greece, the increase in investment activity –and also the increase in consumption– is closely linked with increases in imports. This is the direct result of significant structural imbalances, as the entirety of capital goods in machinery, telecommunications equipment, etc. is imported and is not produced domestically. Thus, historically, every increase in investment, proceeding in tandem with phases of economic expansion, is hindered by a significant drag in the trade balance and a resulting current account deficit. This is a significant structural problem that has to be considered, as it affects the medium- and long-term growth prospects of the Greek economy and also has a destabilising effect on fiscal magnitudes, as the current account deficit gives rise to double deficits.

2.2. Own economic projections for 2023-2024

As we steer into the economic landscape of 2023 and 2024, various scenarios unfold, signifying divergent trajectories for the country's fiscal health and economic growth. Table 2.2.1 presents three different development scenarios: the Baseline, the Optimistic, and the Pessimistic projections. In the Baseline scenario, the government is expected to maintain its fiscal stance from 2022. Encouragingly, even with the hike in spending for 2022, the European Commission has

expressed tolerance due to a healthy debt-to-GDP ratio. The government's commitment appears to be undeterred, as they are poised to enhance household aid for 2023. This approach, mirroring the 2023 expenditure, is also presumed for 2024. This constant government support, matched with an effective absorption from the Recovery and Resilience Fund (RRF) and an upward trend in Foreign Direct Investments, especially in construction, presents a promising picture.

With a projected investment growth of 10% in 2023 and 6.5% in 2024, the investment climate seems bullish. A significant chunk of this investment is funneled into the construction sector, signaling a considerable impact on GDP (see Section 2.7). Service exports are also on the uptrend, predicted to rise by 4% in 2023, buoyed mainly by travel receipts, which are slated to surpass the 2019 levels. While average spending might be marginally subdued compared to 2019, the surge in admissions offsets this lag. Looking into 2024, with tourism already outpacing 2019 figures, we project a moderate growth of around 1%. Aligning all these factors, the economy, under this scenario, is poised to grow by 1.9% in 2023, moderating to 0.9% in 2024.

Shifting the lens to the Optimistic scenario, there is a palpable sense of buoyancy. The state's budget has assimilated all promises made during the pre-election period and the initiatives heralded at the Thessaloniki International Fair. As part of these commitments, policies like increments in civil servants' salaries, removal of freezes on salaried employees, enhanced tax exemptions for families, upward revision of pensions, and a robust investment of 12.1 billion euro are expected to turbocharge income growth. The investments, broken down into 8.5 billion euro from the Public Investment Programme and 3.6 and 1.7 billion euro from the Recovery and Resilience Fund, are earmarked to stimulate the economy in 2024 (for details, see Box 2.2.1). This is, according to the Greek government, bolstered by an 8.3% projected growth in investment for 2023 and a whopping 12.1% in 2024. The health sector is not left behind, with hospitals expecting a 15% uptick in subsidies. This sunny landscape sets the stage for a GDP rise of 2.2% in 2023, crescendoing to 2.8% in 2024.

Table 2.2.1 GDP, employment and imports estimates

	2023	2024
Baseline scenario		
GDP	1.9%	0.9%
Employment	2.1%	1.0%
Imports	1.5%	0.8%
Optimistic scenario		
GDP	2.2%	2.8%
Employment	2.3%	2.7%
Imports	1.6%	2.2%
Pessimistic scenario		
GDP	1.9%	0.2%
Employment	2.1%	0.4%
Imports	1.5%	0.3%

Source: Own estimates.

However, not all forecasts bask in positivity. The Pessimistic scenario offers a sobering perspective, especially considering the ramifications of the Storm Daniel in Thessaly. Initially, the impact of this calamity was believed to be fleeting, with no pronounced influence in 2023. However, the projections for 2024 hint at a bleaker situation. The government's allocation of 2.2 to 2.8 billion euro, aimed to counterbalance the production setbacks, might fall short by 10%. This is even more critical given Thessaly's contribution of 5.5% to the nation's Gross Value Added (GVA). Under these circumstances, the GDP growth, although retaining its 1.9% rise for 2023, is predicted to decelerate alarmingly to a mere 0.2% in 2024. These scenarios underscore the capricious nature of economic forecasting. While internal factors like government spending and policies play a pivotal role, external shocks, such as natural disasters, emphasise the need for adaptive strategies and robust contingency planning.

Box 2.2.1 Greece's financial journey with the EU Recovery Fund: Key milestones and disbursements

To date, Greece has disbursed a total of 11.1 billion euro from the EU Recovery Fund, just 1.5 years after the adoption of its RRP. These funds represent 6.1% of its GDP, making Greece the country that has received the highest disbursement rate in relation to its GDP. Croatia follows with disbursements corresponding to 3.9% of its GDP, Italy with 3.8%, Spain with 3.1%, Romania with 2.6%, and Portugal with 2.4%.

In particular, Greece has, to date, received pre-financing of 3.96 billion euro (August 2021), completed 15 milestones and targets, and disbursed 3.56 billion euro (April 2022) since the first payment request. It also completed a further 28 milestones and targets for the second payment request, disbursing another 3.56 billion euro (January 2023). In fact, on 15 May, it was among the first three countries to submit a third payment request from the RRF, demonstrating the effectiveness of its implementation. The third payment request of 1.72 billion euro brings the total expected inflows from the Fund to 12.8 billion euro.

Timeframe for the implementation of 'Greece 2.0':

- 27.4.2021: 'Greece 2.0' was the second National Plan submitted to the EU.
- 17.6.2021: It received its positive assessment, and on 13.7.2021, ECOFIN approved it.
- 9.8.2021: A pre-financing of 3.96 billion euro was disbursed, corresponding to 13% of the money allocated to Greece from the RRF.
- 21.12.2021: Greece was among the first countries to sign the necessary Operational Arrangements with the Commission.
- 29.12.2021: Greece became the third country (after Spain and France) to submit the first payment request (3.56 billion euro) in line with the timetable foreseen in the Operational Arrangements.

Box 2.2.1 (continued)

- 28.2.2022: The EU published its positive preliminary assessment of Greece's first payment request.
- 8.4.2022: The first tranche under 'Greece 2.0' was disbursed.
- 30.9.2022: The Greek authorities submitted the second payment request (3.56 billion euro) from the RRF. Greece was one of the first five countries to submit a request for the disbursement of the second payment from the RRF. In fact, it was the first to request the third payment (loan programme).
- 25.11.2022: The EU issued a positive preliminary assessment on the request of 30.9.2022.
- 9.1.2023: The Committee responsible for the EU's Recovery and Resilience Mechanism approved the EU's executive decision to disburse 3.56 billion euro.
- The government is now waiting for Ecofin's approval on 8 December to further increase the financial "package" of the RRF to 36 billion euro, with the addition of 5 billion euro in cheap loans, while the fourth request for disbursement of funds will be submitted in the first quarter of 2024.

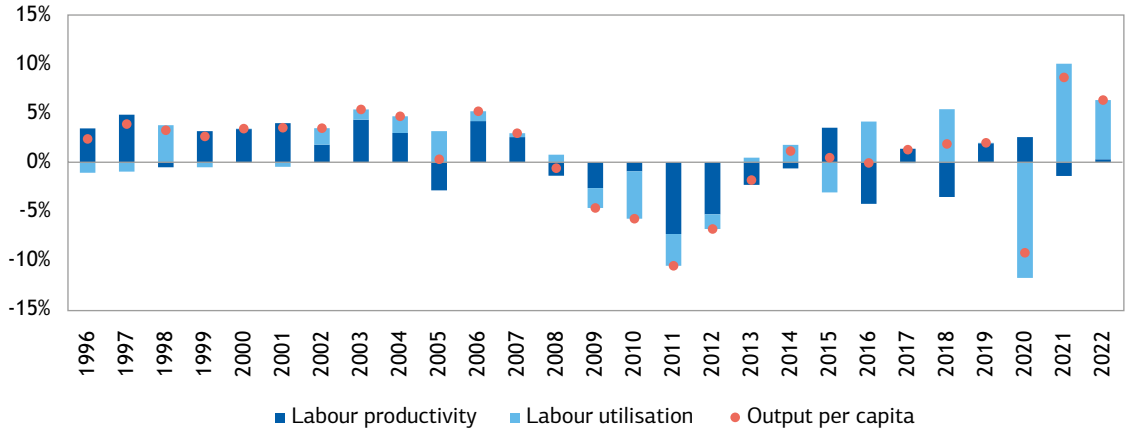
2.3. Aggregate productivity growth

During 2022, real output increased by 5.9%, hours worked by 5.6%, employment by 3.8%, and capital increased by 0.1%. As a result, labour productivity per hour worked increased by 0.3%, and labour productivity per person employed increased by 2.0%, whereas total factor productivity increased by 2.9% using hours worked as the labour input and by 3.8% using employment as the labour input.

In order to obtain additional information on the determinants of labour and total factor productivity, we proceed by decomposing aggregate per capita output growth into changes in labour productivity and labour utilisation (Figure 2.3.1). In particular, we observe the continuation of the rebound in per capita output by 6.3% in 2022, which, in the previous year, can exclusively be attributed to the rebound in labour utilisation, which increased by 6.0%, whereas labour productivity growth, as already mentioned, contributed only marginally by 0.3%.

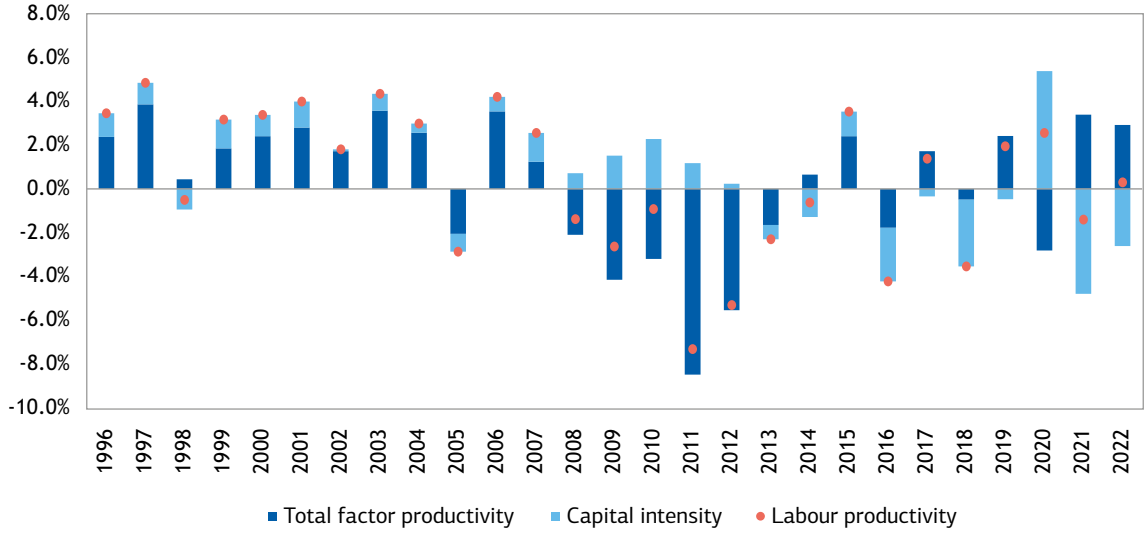
In greater detail, the somewhat marginal increase in labour productivity growth cannot be attributed to the trajectory of total factor productivity –since the latter increased significantly by 2.9%– but instead to the strong influence of a fall in capital intensity, with the latter decreasing by 2.6% (Figure 2.3.2). The fall in capital intensity was, in turn, the result of hours worked increasing significantly faster than the capital stock. We note that this marks the first year of increase in the capital stock after twelve consecutive years of decline.

Figure 2.3.1 Output per capita decomposition, 1996-2022



Source: Eurostat, author's own calculations.

Figure 2.3.2 Labour productivity decomposition, 1996-2022

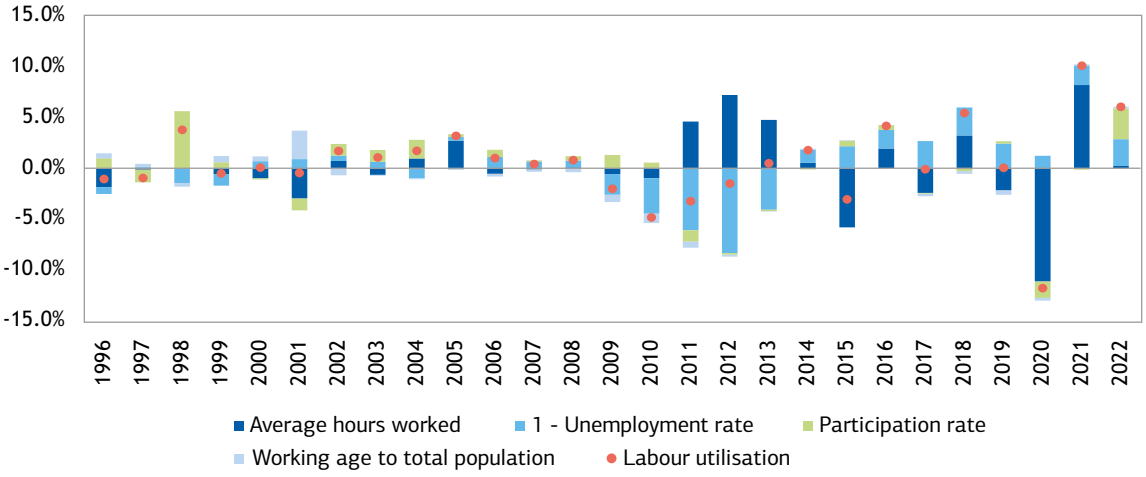


Source: Eurostat, author's own calculations.

Turning our focus to the decomposition of labour utilisation (Figure 2.3.3), we find that the significant increase in that variable can be attributed to the fall of the unemployment rate that contributed 2.6%, to the increase in the participation rate that contributed 3.0%, to a slight increase in the working age to total population ratio that contributed 0.2%, and, finally, to a small increase in average working hours that contributed 0.2%. It is important to note that those figures also indicate that the Greek economy is returning to normal conditions, leaving behind the effects of COVID-19, as in the last year, almost the entirety of the improvement in labour utilisation could be attributed to increases in average hours worked as people returned to work.

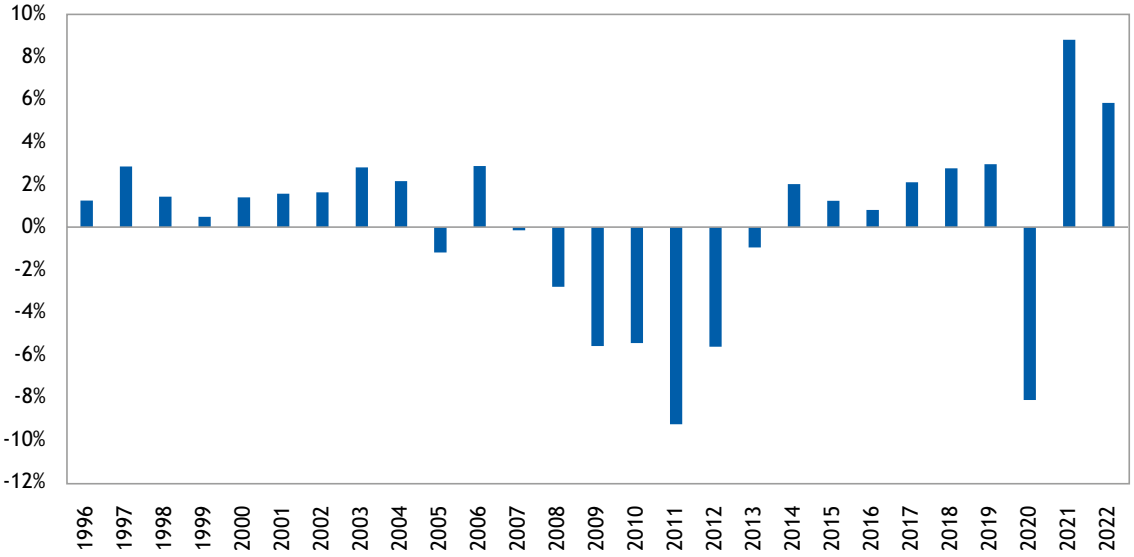
Capital productivity, measured as output per physical capital, is the counterpart of labour productivity and conceptually has an equally important role in determining the standard of living of the population. Physical capital comprises of structures, machinery, including ICT, and intellectual and cultivated assets. Therefore, increasing capital productivity can be equated with more efficient use of capital assets in the production process, and decreasing capital productivity with progressively less efficient use of capital. Our results indicate that capital productivity increased by 5.8% in 2022 (Figure 2.3.4).

Figure 2.3.3 Labour utilisation decomposition, 1996-2022



Source: Eurostat, author's own calculations.

Figure 2.3.4 Capital productivity, 1996-2022



Source: Eurostat, author's own calculations.

Box 2.3.1 Output decomposition

Given that labour productivity can be decomposed into total factor productivity and capital intensity (see, e.g., Gomez-Salvador et al., 2006)

$$\frac{Y}{L} = TFP \times \left(\frac{K}{L_h}\right)^{1-a}$$

and that labour utilisation can be decomposed into effects for average hours worked, the unemployment rate, the employment rate, and aging

$$\frac{L_h}{N} = \left(\frac{L_h}{EMP}\right) \times \left(1 - \frac{U}{LF}\right) \times \left(\frac{LF}{POP}\right) \times \left(\frac{POP}{N}\right)$$

then, output per capita can be decomposed into the effects of labour productivity and labour utilisation:

$$\frac{Y}{N} = \frac{Y}{L} \times \frac{L}{N}$$

with Y being output, L_h hours worked, K capital, a the labour share of income, TFP total factor productivity, N total population, EMP employment, U unemployment, LF labour force, POP population of working age.

2.4. Sectoral productivity growth

Turning to the sectoral dimension of productivity growth in the Greek economy between 2020 and 2022, a significant variation may be found across economic sectors. In particular, we observe that out of the 10 major sectors of the economy, 6 experienced a slight productivity increase, as output increased faster than employment, and 4 sectors experienced a slight productivity decrease (Table 2.4.1).

Grouping sectors according to productivity change, we find that a first group of sectors with very significant productivity increases includes both production and services sectors. In particular, "Construction" experienced a significant rebound both in output and hours worked, leading to a labour productivity increase of 16.2%; the same is true for "Arts and entertainment" with labour productivity increasing significantly at 10.4%.

In a second group of sectors, more moderate labour productivity increases were found in "Professional, scientific and technical activities; administrative and support service activities", with productivity increasing by 6.3%, and in "Wholesale and retail trade", with productivity increasing by 5.1%.

In a third group of sectors, productivity increases were very low but positive. This is the case in "Financial activities" and in "Information and communication activities" where productivity increases were around 1% in both cases.

In a fourth group of sectors, productivity decreased slightly. This is the case in "Agriculture", with a decrease in productivity growth of 2%, in "Industry", with a decrease in productivity of 2.5%, and in "Public administration", with a decrease in productivity of 3.1%.

Finally, "Real estate activities" appear to be an outlier, since productivity decreased by 7.7% as a result of significant increases in labour input. This result, however, is not particularly disconcerting, mainly for two reasons. First, real estate activities output includes imputed rents on household dwellings, i.e. a somewhat fictitious element. Second, the level of employment in the real estate sector was and still remains very low, thus significantly increasing the impact of percentage changes in employment.

Table 2.4.1 Changes in labour productivity growth per sector, 2020-2022

Code	Sector	Labour productivity	GVA	Hours worked
L	Real estate activities	-7.7%	0.3%	8.7%
O-Q	Public administration, defence, education, human health and social work activities	-3.1%	-0.9%	2.2%
B-E	Industry (except construction)	-2.5%	1.6%	4.2%
A	Agriculture, forestry and fishing	-2.0%	1.3%	3.3%
J	Information and communication	1.0%	4.5%	3.5%
K	Financial and insurance activities	1.0%	2.4%	1.3%
G-I	Wholesale and retail trade, transport, accommodation and food service activities	5.1%	12.6%	7.2%
M-N	Professional, scientific and technical activities; administrative and support service activities	6.3%	13.5%	6.8%
R-U	Arts, entertainment and recreation; other service activities; activities of households and extra-territorial organizations and bodies	10.4%	24.9%	13.2%
F	Construction	16.2%	26.0%	8.4%

Source: Eurostat, author's own calculations.
Note: Sectors are mentioned in order of increasing labour productivity.

2.5. Demographics and productivity growth

The main demographic issue, which has a direct effect on the projections of economic activity, is that the population of Greece is declining and getting older. We note that demographic decline is not a problem that affects only Greece, but is common among all advanced economies. However, in the case of Greece, demographic decline expresses itself in an acute manner, leading to significant economic implications that affect critical macroeconomic variables. In particular, the latest Population Census (2021) data shows that, since the onset of the Greek debt crisis in the early 2010s, the population of Greece has declined by 3.5%, as a result of both natural and migration flows. Projections indicate that the current trend will persist and that by 2050, the decline in population will be between 7.3% and 23.4%, compared with the population of 2015.[1] For the same period, Eurostat provides a narrower band of estimates, that project a population decline between 11% and 17% (Figure 2.5.1). Moreover, persons at an age between 15 and 64 years, i.e., the working age population, will decrease by 20% to 35%.[2] It is important to note that even in the least favourable projections, migration flows are practically balanced, and, therefore, current projections do not incorporate the possibility of a sustained outflow of population. Such an outcome would have a significant adverse effect on the population and, especially, working age population projections.

The main economic effects of the current population trends are obviously negative:

- Population aging poses a significant threat to the viability of current pension and healthcare systems.
- A declining population results in a net reduction of human capital, therefore hampering future economic potential.
- Without a substantial increase in labour productivity, or an increase in labour participation rates, a reduction in population will lead to a decline in GDP.

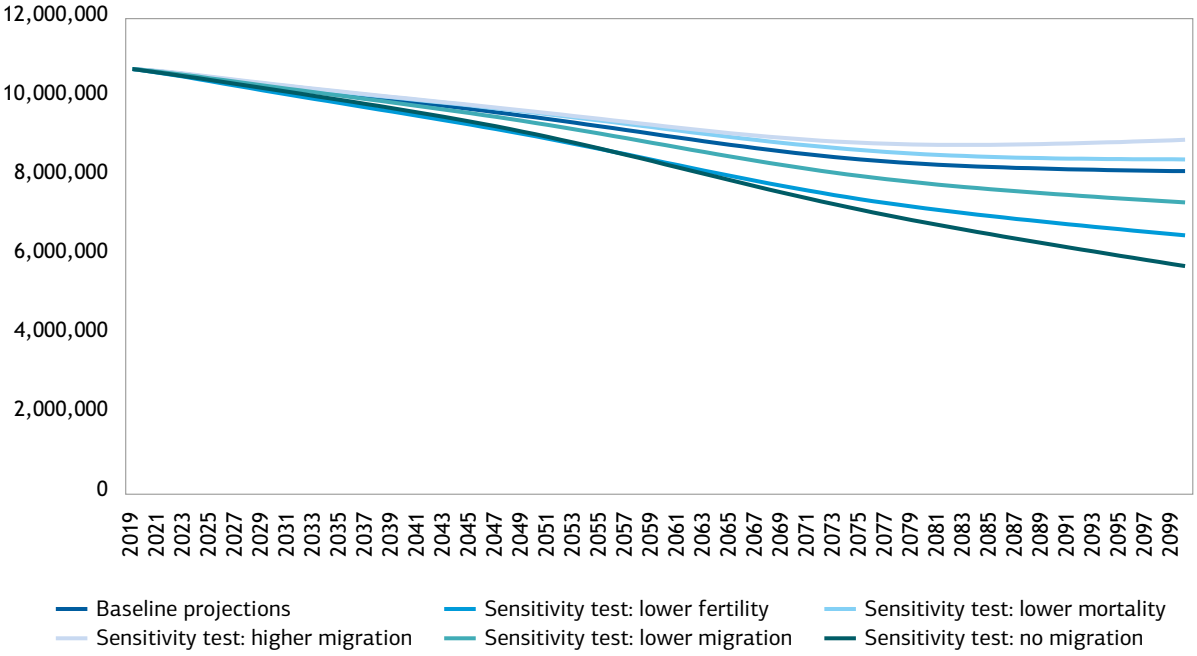
Using the Eurostat's population projections, assuming that per capita output remains at the level of 2022, the projected reduction in output will be between 9% and 15%, or between 18 and 29 billion euro for the period between 2022 and 2050.[3] The baseline projection indicates an output level of 175.5 billion euro by 2050. A sensitivity analysis focusing on the adverse scenario of lower fertility indicates an output level of 165.7 billion euro, while a sensitivity analysis focusing on the favourable scenario of lower mortality indicates an output of 176.6 billion euro. Given the importance of estimated migration flows, three alternative scenarios are considered with the most favourable scenario of higher inflows indicating an output level of 177.1 billion euro, a more adverse scenario of lower migration accounting for an output level of 171.9 billion euro and,

1. Parliamentary Report on Demographics 2018, p.75.

2. Parliamentary Report on Demographics 2018, p.80.

3. Our projections of GDP levels are estimated in the following manner: first, the per capital level of output in 2022 is estimated as GDP to population; second, the level of estimated output on a future date is calculated as the product between the estimated population level, using Eurostat's estimates, and the per capita level of output in 2022.

Figure 2.5.1 Population projections



Source: Eurostat.

finally, the most adverse scenario of no migration flows into the country indicating an output level of 166.6 billion euro by 2050.

Given that, in the medium term, the effects of population decline and aging are not reversible, it is necessary to implement several policies to counteract this tendency. The first such policy is a focused investment strategy that will significantly increase the available capital per worker in order to boost productivity. In parallel to the investment strategy, the second such policy is the implementation of an employment strategy that will increase female labour participation (currently 60%) at least to the level of male labour participation (currently 75%). The third such policy should aim at the minimisation of unemployment and the maximisation of activity rates. Finally, the fourth such policy should focus on intangibles, allowing for those changes in organisation, technology, and managerial practices that will help boost productivity in the medium run, such as changes in the work-life balance, flexibility in workhours, increased digitalisation, etc. In the long term, it is necessary to provide the framework that will result in reversing both natural and migration flows to positive. Critical to the success of this long-term strategy is to reverse the outflow of highly educated young people ('brain drain') and, moreover, to provide incentives for the repatriation of those who emigrated during the last decade of economic crisis ('brain gain'). It is also critical to provide the necessary incentives and support for health services for increased fertility and for social policies aiming at supporting young mothers and couples, especially measures that support working mothers. In this direction, the development of public childcare facilities and services and the expansion of full-day school

programmes would help female labour participation. Moreover, Greece has to be engaged in an active migration policy aiming to attract high-skilled individuals and to provide the necessary framework for the smooth integration of those into Greek economic and social life.

Finally, the spatial dimension reserves a special role in the discussion of future demographics and economic projections. In particular, despite the fact that since 2011 the aggregate population has declined by 3.5%, this decline was not distributed equally across regions. Current estimates indicate that 4 out of 10 municipalities have seen population declines from 5% to 20% (Kotzamanis, 2022). This outcome, coupled with the lasting effects of the previous economic crisis, create spatial pockets of very low economic growth and, therefore, disrupt the social and economic fabric.

2.6. Effects of capital stock estimates on total factor productivity

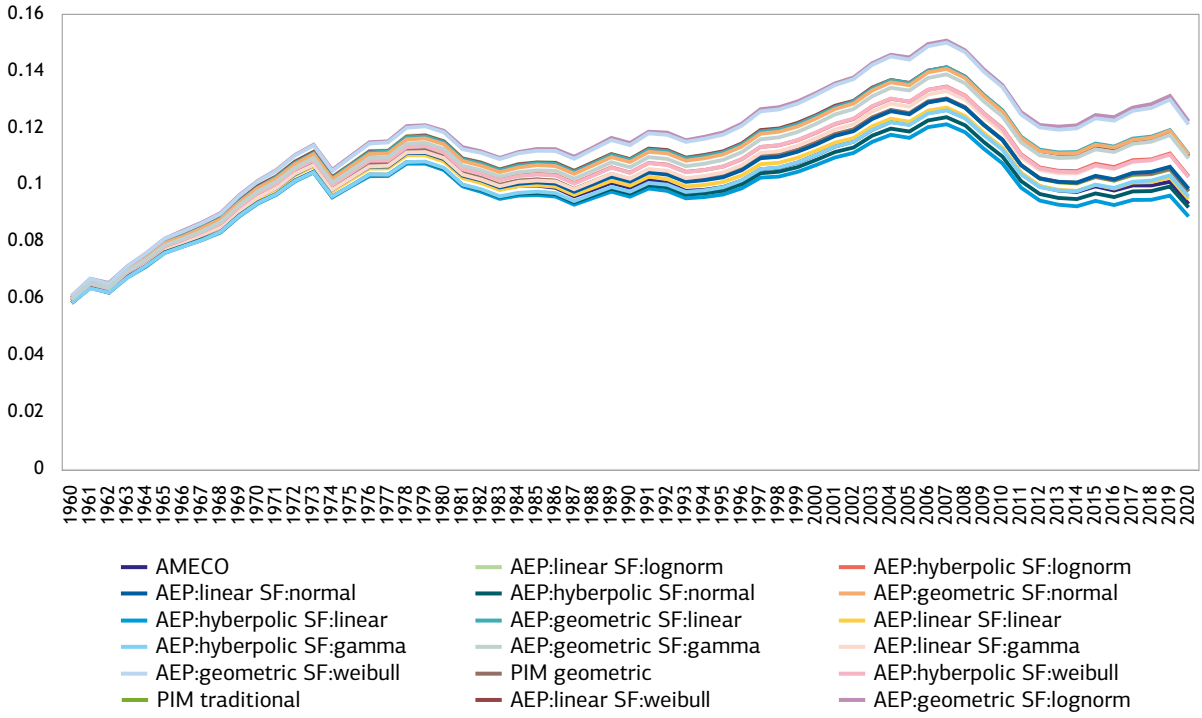
This section presents the results of a new set of standardised capital stock estimates on the TFP of the Greek economy, testing for the effect of various survival functions (SFs) and age-efficiency profiles (AEPs). The findings are based on the recent study by Passas (2023), and the data used originate from the AMECO database. The trajectory of the capital-output ratio was found to greatly depend on the specification used for the implementation of the perpetual inventory method to estimate the capital stock. Here, we demonstrate the effect of different capital stock estimates on total factor productivity over the long run.

Total factor productivity is estimated using a traditional growth accounting framework that utilises a Cobb-Douglas production function with constant returns to scale. In particular, we use total employment as a proxy for the labour input and GDP at constant prices as a proxy of output. Moreover, we assume that, on the basis of historical values, the output elasticities of labour and capital are both equal to 0.5.

In Figure 2.6.1, we observe that different estimates of capital stock based on different assumptions regarding the shape of the AEPs and the shape of SFs lead to significantly different estimates on the level of TFP. However, the growth rates of various TFP measures were found to be similar.

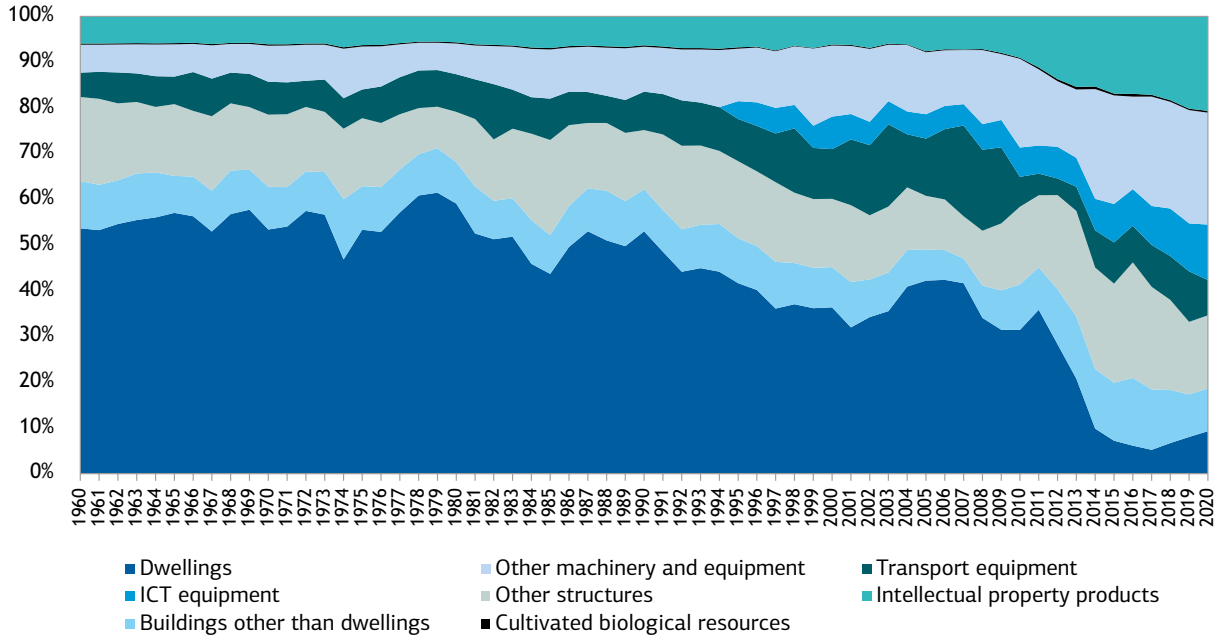
In addition, we note that the composition of the capital input measure has a significant effect on total factor productivity. In particular, capital consists of the following broad categories of assets: first, construction assets, which include: (a) dwellings and other buildings and structures, (b) equipment, including machinery, transport, and ICT equipment, (c) cultivated assets, and (d) intellectual property products. Given that the average service life of each category of assets is significantly different, ranging from a service life of 65 years for dwellings to just 8 years for intellectual property products, the composition of the capital stock will have a significant impact on its average depreciation rate and, thus, on the level of total factor productivity. Figure 2.6.2 presents the composition of investment by broad asset classes, which can be considered as indicative of the significance of those asset classes to the final composition of the capital stock measures.

Figure 2.6.1 Sensitivity of total factor productivity to capital stock estimates



Source: AMECO, author's estimates.

Figure 2.6.2 The composition of Greek investments by broad capital assets classes, 1960-2020



Source: *National Accounts,* author's own estimates.

From Figure 2.6.2, it is apparent that the composition of investment by asset classes remained fairly stable from the 1960s up until the early 1990s. After that period, two significant compositional changes took place: first, the Information and Communication Technology (ICT) equipment and intellectual property rights products began to increase and, second, after the onset of the economic downturn in the second decade of the 21st century, the investment in dwellings collapsed. Therefore, as a first approximation, we could argue that variations in the composition of investment by asset classes is correlated with changes in TFP, with the literature suggesting a close link between ICT investment and increases in TFP.

2.7. Evaluation of investments from the Greek Recovery and Resilience Plan

2.7.1. Methodology for estimating the efficacy of the initial RRP budget

In this section, the primary objective is to critically evaluate the efficacy of the initial RRP (Recovery and Resilience Plan) budget for Greece in addressing both immediate goals, i.e., economic recovery and job creation, and long-term aspirations, such as enhancing productivity, curtailing import dependency, and mitigating CO2 emissions. To achieve a comprehensive understanding, we investigate the multiplier effects of the RRP budget on a range of parameters, including output, employment, imports, and CO2 emissions. This analysis paves the way for a more elaborate inter-sectoral exploration of the Greek economy.[4]

The methodology adopted for this study hinges on an extended matrix multiplier framework, with the latest available data from the Organisation for Economic Cooperation and Development (OECD), serving as the empirical backbone to understand the intricacies of the Greek economic landscape. While many contemporary models, especially advanced Input-Output (IO) ones, tend to centre around measuring multipliers, the approach here is notably broader. It encompasses not only the technical conditions of production but also emphasises intricate feedback mechanisms influenced by factors such as imports, income distribution, savings accrued from wages and profits, and evolving consumption patterns. For a nuanced analysis, the study incorporates detailed RRP budget data, which is presented exclusive of VAT and inclusive of any relevant discounts.

These funds will be spread over the 2021-2026 timeframe, enabling the Greek Government to carry out the necessary investments and reforms outlined in the plan (channels of impact). For a detailed list of these channels of impact, i.e., 68 reforms and 106 investments, see European Commission (2021a; 2021b) and Greek Government (2021). Furthermore, the analysis of the data shows that there are 10 types of costs. These types of cost and their correspondence to industries are:

4. It should be noted that the only detailed budget information regarding 2021-2026 provided to us is the initial RRF budget (without VAT, including discounts), analysed hereinafter.

1. The construction cost is directly related to the construction industry.
2. The equipment cost is associated with the machinery and equipment sector, not elsewhere classified (nec).
3. The man-months cost is a composite, encompassing industries such as wholesale and retail trade, repair of motor vehicles, IT and other information services, professional, scientific and technical activities, as well as administrative and support services.
4. Interestingly, there is no industry that corresponds to the benefits cost.
5. The studies cost is linked to professional, scientific, and technical activities.
6. The project management cost is tied to both professional, scientific and technical activities and administrative and support services.
7. Archiving costs are associated with IT and other information services.
8. Vouchers costs are related to the computer, electronic, and optical equipment industry.
9. Licenses are also related to the computer, electronic, and optical equipment industry.
10. Lastly, costs for cloud upgrades and hosting are attributed to IT and other information services.

Thus, these cost types and their industry correspondence provide a comprehensive overview of the RRP budget's allocation. All the above can be further analysed in detail for 145 channels of impacts, i.e., in terms of spending for specific investments and reforms.[5] Figure 2.7.1 presents the amounts of the channels of impacts per type of cost (in the order presented above: 1-10) and per year (i.e., for each n from 2021-2026: 202$n \rightarrow n$).

Box 2.7.1 The CO2 emissions multipliers

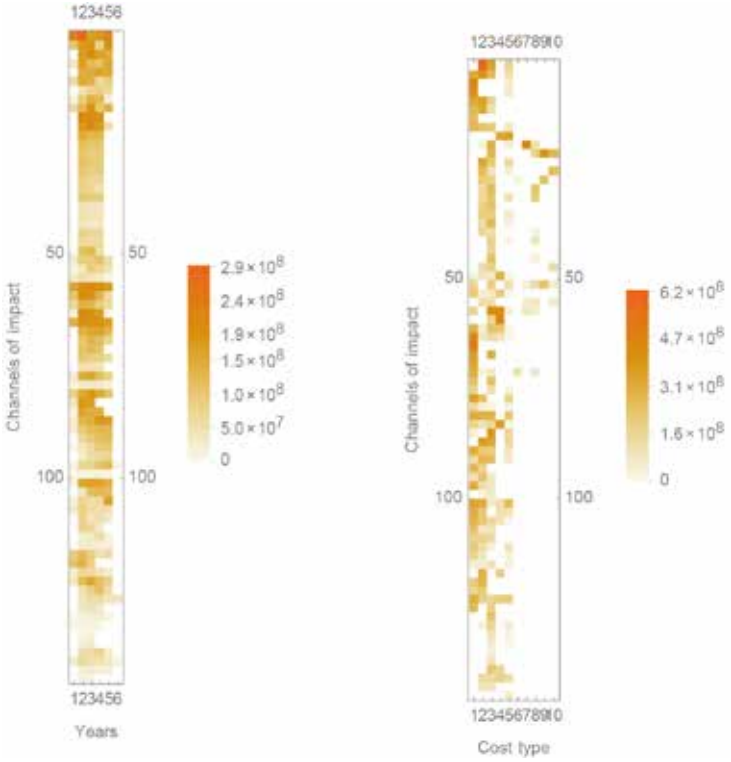
Drawing upon the framework delineated in Greek NPB (2020; Box 2.4.1), beyond the output, employment, and import multipliers, it is feasible to extrapolate the matrix multiplier that correlates autonomous demand with CO2 emissions. We can further define the matrix multiplier that associates autonomous demand with CO2 emissions as:

$$\mathbf{CO2} = \mathbf{K\Pi} \times \mathbf{d}$$

where $\mathbf{K\Pi}$ denotes the $n \times n$ matrix of CO2 emissions multipliers linking autonomous demand to the $n \times 1$ vector of $\mathbf{CO2}$ emissions, and $\mathbf{d}$ denotes the $n \times 1$ vector of autonomous demand.

5. We have removed all the projects that corresponded to zero expenditure.

Figure 2.7.1 The amounts of channels of impacts per type of cost and year



2.7.2. Results of the empirical evaluation analysis

The application of the input-output tables (IOT) analysis of the Greek economy gives the net output, employment, import and CO2 multipliers, which are summarised in Figure 2.7.2. The first column of Figure 2.7.2 indicates that an increase (decrease) of 1 monetary unit in the autonomous demand for "Agriculture, hunting, forestry" induces an increase (decrease) of 0.90 monetary units in net output, an increase (decrease) of 0.29 monetary units in imports, an increase (decrease) of 42.29 units in employment and an increase (decrease) of 210 tonnes of CO2 emotions. The remaining columns of this table are read in the same way. Thus, it follows that an increase (decrease) of 1 million euro in the autonomous demand induces, on average, an increase (decrease) of 0.90 million euro in net output, of 0.29 million euro of imports, of 42.29 people in employment, and of 210 tonnes of CO2 emissions.

We then analyse the multiplier effects by sector of production (see Table 2.7.1). The Primary sector demonstrates a strong contribution closely mirroring the national average. Specifically, its leading indicators are quite robust, with values nearly matching the overall Greek economic average. However, its efficiency or productivity seems slightly below the national mean. In contrast, the Secondary sector, while showcasing values below the national and primary sector standards in its initial indicators, distinguishes itself with a notably higher multiplier. This outcome suggests a significant influence of every unit of input on the output in this sector. Moreover, its efficiency or productivity surpasses both the primary sector and the Greek average.

Figure 2.7.2 Multipliers by industry (a) output, (b) employment, (c) import and (d) CO2 emissions

Figure 2.7.2 (continued)

(b)

Figure 2.7.2 (continued)

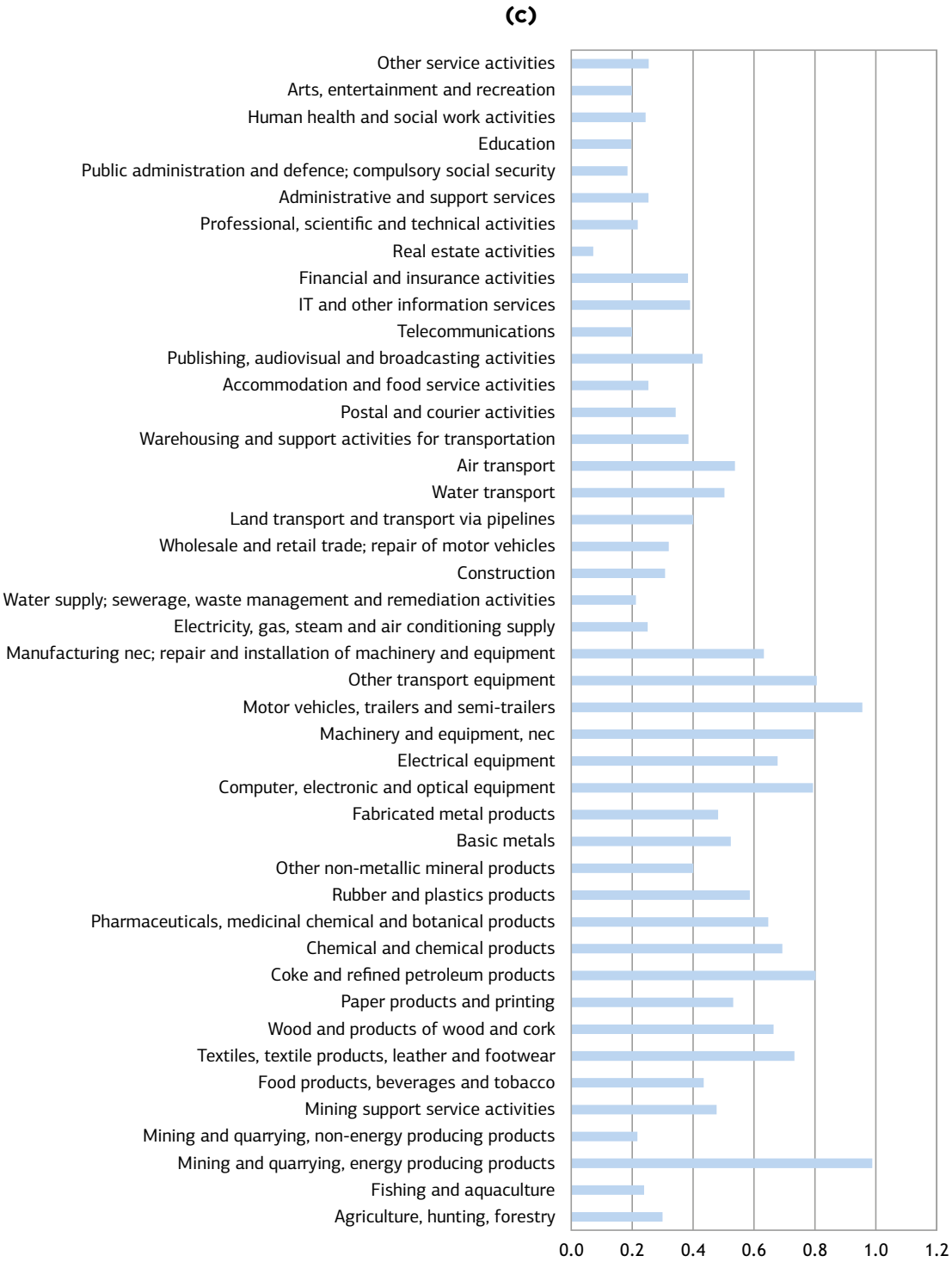


Figure 2.7.2 (continued)

The Tertiary sector stands out with its dominant initial indicators especially, its contribution surpassing both the primary and secondary sectors. However, this sector's multiplier effect, indicative of the influence of every unit of input on the output, is the least among the three, which might imply certain inefficiencies or the nature of services offered in this sector. The sector's efficiency or productivity hovers just below the national average.

Note that the output-to-labour ratio, also understood as the output multiplier compared to the labour multiplier, which can be considered as a (labour) productivity index, exceeds the national average. Interpreting these ratios as productivity measures suggests their importance in the short-term effective demand management policy. For a longer-term strategy that aims to boost the economy's productivity, the focus should be on commodities with higher productivity scores. These specific commodities, which have an output-to-labour ratio above the average, can be identified as critical for the Greek economy's structural policy (for more details, see Apostolopoulos et al. [2022] and Mariolis, Rodousakis, and Soklis [2022]). Furthermore, the incremental output-import ratios can be conceived as indices of relative import dependency (import indices). The interpretation of the output-to-CO2 ratio is similar, i.e., as a CO2 emissions index. Table 2.7.1 shows the above mentioned indices by sector of production.

Moving on to the technology (tech) classifications, the output, employment, imports and CO2 emissions multipliers and the relevant indices by technology are given in Table 2.7.2. The Low-tech category seems to have the highest multiplier effect, but demonstrates a lag in efficiency or productivity. The Medium-tech category places itself generally in the mid-range across the indicators, neither leading nor lagging distinctly. However, the High-tech sector is particularly intriguing. Despite its lagging performance in the primary indicators, where the High-tech sector falls behind other sectors in terms of output, employment, imports, and CO2 emissions, it stands

Table 2.7.1 Output, employment, imports and CO2 emissions multipliers by sector

	Output	Employment	Imports	CO2	Productivity index	Import index	CO2 index
Primary	0.87	24.84	0.42	249.03	0.03	2.10	0.003
Secondary	0.69	17.72	0.55	388.17	0.04	1.25	0.002
Tertiary	1.09	24.31	0.29	281.50	0.05	3.71	0.004

Source: Authors' estimates.

Table 2.7.2 Output, employment, imports and CO2 emissions multipliers by technology

	Output	Employment	Imports	CO2	Productivity index	Import index	CO2 index
Low-tech	0.62	16.98	0.60	177.41	0.04	1.03	0.003
Medium-tech	0.65	11.82	0.56	544.81	0.06	1.17	0.001
High-tech	0.35	6.14	0.77	100.97	0.06	0.46	0.003

Source: Authors' estimates.

out for its remarkable efficiency and productivity. This means that despite lower values or influence in these primary areas, the High-tech sector is exceptionally adept at generating substantial output or value with relatively fewer resources, and it is second in efficiency and productivity only in the Secondary sector.

This might suggest that while the sector is not as influential in its overall contribution, its operations are efficient. In essence, while each sector and tech category brings its unique strengths and challenges to the Greek economy, there is a notable disparity in multipliers and efficiencies, highlighting potential areas of focus for economic policymakers.

The Greek economy's comprehensive analysis indicates that both the primary and the services sectors are poised to boost short-term economic growth due to their above-average output and employment multipliers and below-average import multipliers. Meanwhile, the secondary sector, characterised by higher labour productivity and import dependence, necessitates long-term policies to increase productivity, lower import dependency, and enhance global competitiveness. The potential for innovation and skills development within this sector is significant. Public spending's high labour productivity and low import dependency suggest it can effectively drive economic growth. However, the export sector's high import dependence underscores the need for policies to promote domestic production over imports, bolstering the domestic value chain and economic resilience. As the secondary sector is export-oriented and has a significant environmental impact, especially concerning CO2 emissions, its development should prioritise eco-friendly technologies and practices to ensure sustainable, competitive growth.

To estimate the multiplier effects of RRP, we set the elements of the vector of autonomous demand equal to the weighted distribution of the RRP budget of each challenge of impacts to the 45 industries of the Greek economy. On this basis, we can provide the multiplier effects of each RRP project[6] to offer an in-depth evaluation of the potential consequences of Greece's preliminary RRP budget. Utilising a comprehensive multisectoral model coupled with the 2018 OECD IOTs, the study ascertains the implications of the allocated RRP budget of 18.2 billion euro for the Greek economy. Table 2.7.3 provides an estimate of the impact of the plan in absolute terms and as a share of output, on the level of employment, imports and CO2 emissions, in each year from 2021 to 2026.

The findings reveal a dual narrative. On the one side, the said budget is projected to catalyse a substantial boost in economic output, approximately 13.7 billion euro. This upsurge in production would parallel an impressive escalation in employment opportunities, potentially adding around 409,098 jobs to the economy. On the flip side, however, the country might observe a rise in imports, approximated at 7.34 billion euro, along with an increase in CO2 emissions pegged at roughly 3,776 KT. When these outcomes are juxtaposed against the GDP and the employment metrics of Greece for the year 2020, the projections suggest an accumulative surge in output by roughly 8.3 percent. Similarly, there would be a consequential boost in employment by about 10.5 percent.

Diving deeper, out of the myriad expenditure categories associated with the RRP, two particular types, namely, Construction and Man-months, emerge as critical levers. These sectors alone are

6. Our estimations for net output correspond to GDP minus net taxes on products.

Table 2.7.3 The initial RRP budget effects on output, employment, imports and CO2 emissions per year between 2021-2026

Impact	2021	2022	2023	2024	2025	2026
Output	545.92	3,834.34	3,968.23	3,291.35	2,077.44	11.288
(%)	*0.33*	*2.32*	*2.40*	*1.99*	*1.26*	*0.01*
Employment	15.77	111.42	118.405.12	98.466	64.746	0.286
(%)	*3,85*	*27.24*	*28.94*	*24,07*	*15.83*	*0.07*
Imports	423.05	2,166.94	1,968.56	1,631.17	1,137.86	3.445
(%)	*0.87*	*4.46*	*4.05*	*3.36*	*2.34*	*0.01*
CO2	15.15	1.023.23	1,076.11	909.549	612.932	1.908
(%)	*0.28*	*1.92*	*2.02*	*1.70*	*1.15*	*0.00*

Source: Authors' estimates.

anticipated to drive an increase in cumulative output by approximately 5.0 percent, accounting for 60 percent of the total output enhancement. Concurrently, they would catalyse employment growth by about 7.07 percent, making up 66 percent of the total projected employment boost.

Interpreting these findings in the context of the broader economic landscape, from 2021 to 2026, the RRP seems poised to play a pivotal role in bolstering both output and employment in Greece. This indicates a substantial stride towards achieving the objective of economic rejuvenation following the setbacks of the COVID-19 pandemic. Nonetheless, when benchmarked against Greece's economic zenith of 2008, the current recovery trajectory, though commendable, appears insufficient.

Moreover, a granular intersectoral exploration suggests a potential misalignment with long-term strategic goals that fits into our intersectoral analysis of the Greek NPB (2020).[7] The current blueprint of the RRP might not entirely cater to the broader aspirations of fortifying productivity and fostering both economic and social resilience. Specifically, there seems to be a deficit in emphasis on sectors marked by elevated productivity, diminished import reliance, and lower CO2 emissions. It should be noted that we observe that 60% of output multiplier effects are concentrated in "Modernise and improve resilience of key economic sectors", "Renovations", "Education, vocational education, training, and skills", and "Increasing job creation and participation in the labor market".

Finally, as the government eagerly awaits Ecofin's approval on 8 December 2023, there is a plan to bolster the financial "package" of the RRF through the incorporation of an additional 5 billion euro in affordable loans. Subsequent to this, the fourth request for the disbursement of funds is slated for submission in the first quarter of 2024. Notably, an RRF allocation of 4.690 billion euro is poised to produce a cumulative effect, enhancing output by approximately 1.8% and elevating employment levels by roughly 2.6%.

7. See also Mariolis, Rodousakis, and Soklis (2022) and Tsekeris et al. (2023).

3. Competitiveness Trends and Outlook

3.1. Recent developments in public finance and the current account

Greece broke the "psychological barrier" of €100 billion in revenues for the first time as it recorded a historical high of €104.4 billion in revenues in 2022. It seems that the main driver of such a record is indirect taxes, which also hit a record high in 2022 both in absolute terms (€39.8 billion) and as percentage of GDP (19.1%). However, given the €109.1 billion in expenditure, which amounts to the top 35% of the historical empirical distribution of expenditure, Greece suffered a budget deficit of €4.7 billion in 2022. This deficit is the smallest one recorded in the examined period (2008-2022). To put it differently, revenues, expenditure, and the budget balance in 2022 are equal to, respectively, 50.2%, 52.5% and -2.3% as a percentage of GDP (see Figure 3.1.1).[8]

Moreover, it is noteworthy that subsidies, part of expenditure, have shown an increasing trend in the last three years (3.8% in 2020, 4.8% in 2021, 5.4% in 2022) far exceeding the historical average of 0.8% during the period 2008-2019. Subsidies have increased in recent years due to (a) power bill grants as a measure of energy financial relief for Greek households and businesses, and (b) COVID-19 grants offered to Greek firms to survive lockdowns.

When we add interest paid (€5 billion) to the budget balance, the primary balance of Greece becomes marginally positive (almost €0.3 billion), taking a value of 0.1%, as percentage of GDP, after two years of negative performance: -6.7% in 2020 and -4.7% in 2021 (see Figure 3.1.1). Regarding interest paid, there are also two remarkable facts: it [1] presents a downward trend as a percentage of GDP from 2011 onwards, and [2] remains lower than €10 billion from 2013 onwards.

The Greek government's debt-to-GDP ratio decreased from 194.6% in 2021 to 171.3% in 2022 (see Figure 3.1.1), implying a huge drop of 23.3 percentage points (pp), the greatest in the EA19 in the last seven years (2016-2022). However, this fall is purely a denominator effect as the nominal GDP increased due to soaring inflation (9.3% according to the HICP for Greece). The government debt in absolute terms, on the other hand, continues its upward trend from €311.7 billion in 2015 to 356.3 billion in 2022. Alternatively, the denominator increased more (14.5%) than the numerator (0.8%), and as a result, the debt-to-GDP ratio plummeted. Of course, it is important and a good sign that the debt-to-GDP ratio decreased, and that the nominal GDP rose in 2022. But such *siren calls* of debt improvement should be avoided, and Greek authorities should not rest on their laurels. There has to be caution and vigilance, and there is no time for complacency as the government debt surpassed the 2010 (€330.6 billion) and 2011 (€353.2 billion) levels, which led Greece to a prolonged period of austerity and a series of memoranda from which it has not yet recovered.

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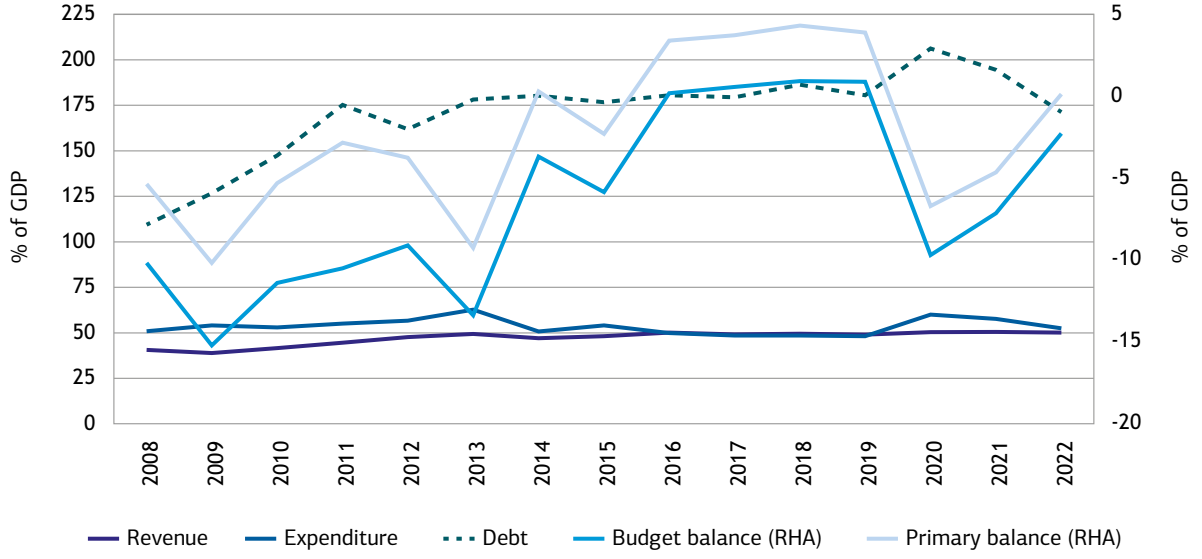
8. EU fiscal rules suggest a ceiling equal to 3% of GDP for the overall fiscal deficit, as well as a public debt ceiling 60% of GDP.

Figure 3.1.1 General government budget and primary balance, revenue, expenditure, and debt (Greece)

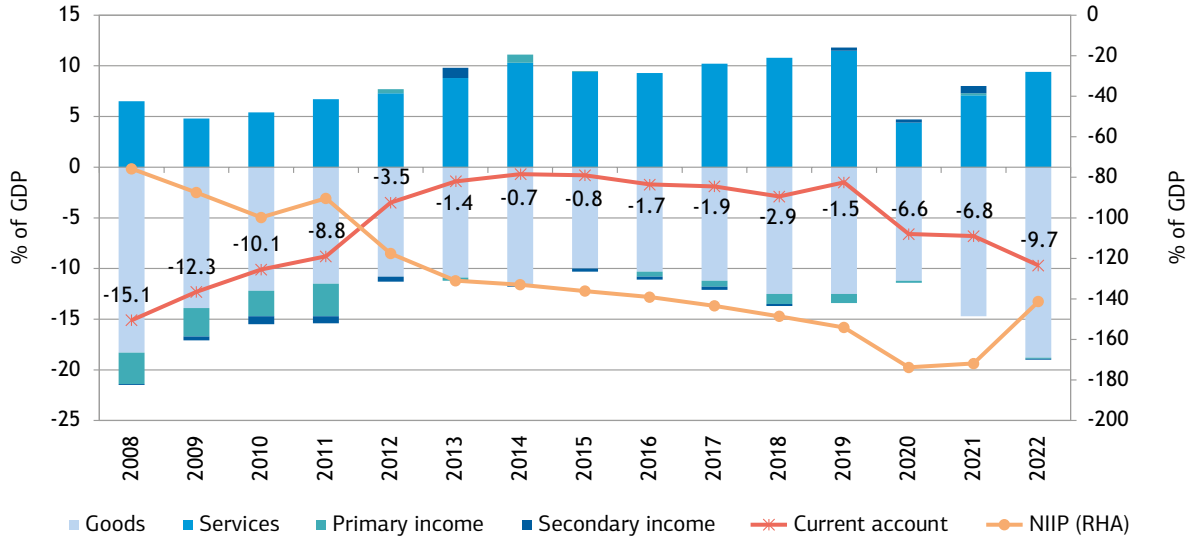


Source: Eurostat.

Next, Figure 3.1.2 illustrates Greece's current account balance, components, and net international investment position (NIIP). First, we observe that Greece faces negative values in the current account (as % of GDP) during the whole examined period, and given the budget deficit in the last three years (2020 to 2022), the "twin deficit" phenomenon emerges in the Greek economy. Next, it seems that the current account continues its downward trend, which started in 2019, and takes a value of -9.7% in 2022. This value is the lowest in the EU27, with the second lowest being -9.3% for Romania. On the other hand, Denmark and the Netherlands record the first and second highest values, respectively, at 13.7% and 9.2%. Regarding the balance of goods, Ireland hits the highest value in 2022 at 40.7%, Croatia suffers a deficit of 26.9%, and Greece records the third lowest value in the EU27 at -18.8%, which is, at the same time, the worst performance in the Greek economy during the examined period.

Turning to the balance of services, Luxembourg has the greatest value in the EU27 at 31.8% and Malta the second highest at 29.9%. The Greek balance of services is 9.4% in 2022, lying in the top 30% of the historical empirical distribution of the Greek economy in the examined sample. At the same time, the upward trend continues in the balance of services for Greece as the previous two values were 4.4% in 2020 and 7.1% in 2021. Furthermore, the primary and secondary income are both negatively valued in 2022 for Greece at -0.1%, but higher than the respective EU27 cross-sectional averages (-3.14% for primary income and -0.37% for secondary income). Finally, Greece and Ireland have been sharing the first two positions with the worst performance in *NIIP*, as a percentage of GDP, since 2016. In fact, Greece exhibited the second worst *NIIP* from 2016 (-139.1%) to 2020 (-173.8%), and in the next two years, it dropped to the last place. More specifically, *NIIP* took a value of -171.9% in 2021, which decreased to -141.3% in 2022.

Figure 3.1.2 Current account balance, components, and NIIP (Greece)



Source: Eurostat.

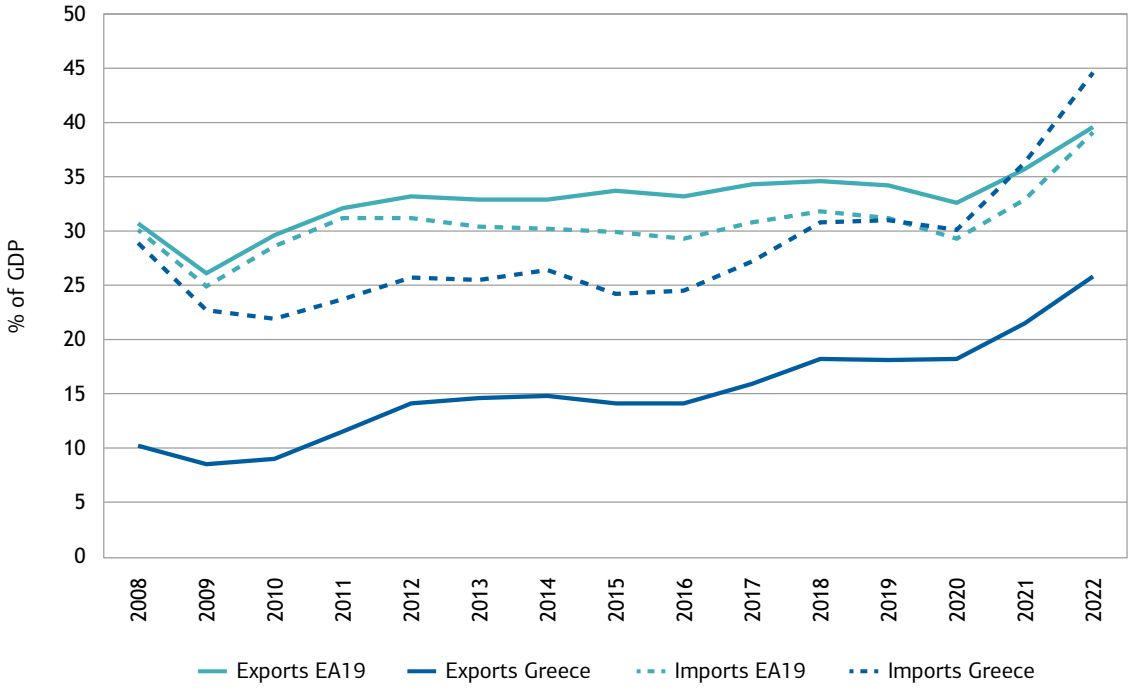
Regarding imports and exports, we notice in Figures 3.1.3 and 3.1.4 that Greece faces a persistent deficit in goods and a persistent surplus in services. On the other hand, there is a small positive gap for the EA19 between exports and imports, signaling that the EA19 is close to equilibrium in terms of trade. Also, one could argue for Greece that a great part of the surplus in services is sustained by the deficit in goods.

Greek exports of goods are well below those of the EA19, but in 2022, the gap between Greece and the EA19 hits the maximum value at -13.8 pp. Also, Greek exports of services exceed those of the EA19, and in 2022 the deviation of Greece from the EA19 records the highest value at 7.5 pp. Moreover, there is a negative gap of imports of goods between Greece and the EA19 up to 2019, which turns to positive from 2020 onwards, denoting that Greece has been importing more goods than the EA19 (as percentage of GDP) in recent years. Finally, Greek imports of services are slightly lower than those of the EA19 (the historical average is about -2.1pp), and in 2022 the gap between Greece and the EA19 is -0.6 pp.

The trade-balance (TB) ratio of Greece and the EA19 is depicted in Figures 3.1.5 and 3.1.6. Figure 3.1.5 shows the TB ratio for goods and Figure 3.1.6 for services. We define *TB* as the value of exports over the value of imports and it is a unit-free measure.[9] When *TB* takes values lower (greater) than 1, there is trade deficit (surplus) as exports are smaller (larger) than imports. In the case of unity, i.e. *TB* = 1, there is equilibrium in the balance of trade.

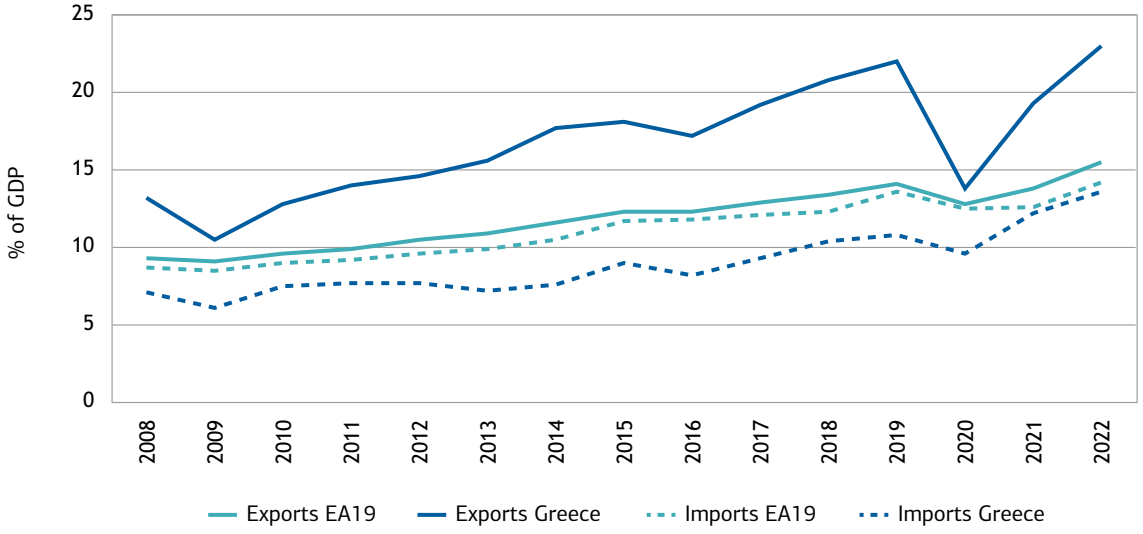
9. For more details, see, among others, Bahmani-Oskooee, Harvey, and Hegerty (2018) and Bertsatos, Tsounis, and Agiomirgianakis (2023).

Figure 3.1.3 Exports and imports of goods in Greece and the EA19 (% of GDP)



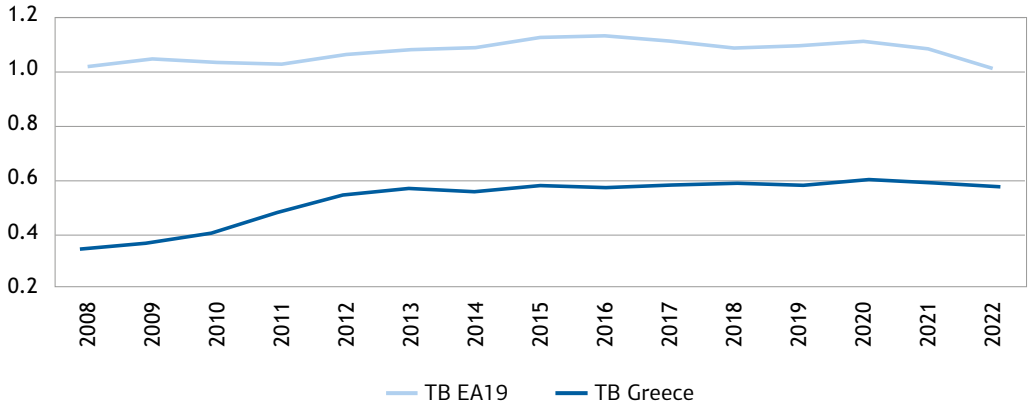
Source: Eurostat.

Figure 3.1.4 Exports and imports of services in Greece and the EA19 (% of GDP)



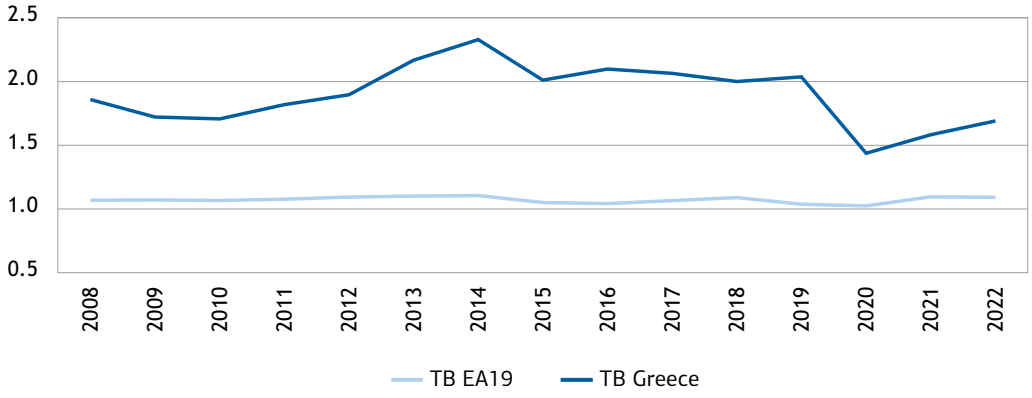
Source: Eurostat.

Figure 3.1.5 Trade-balance ratio (TB), based on goods, of Greece and the EA19



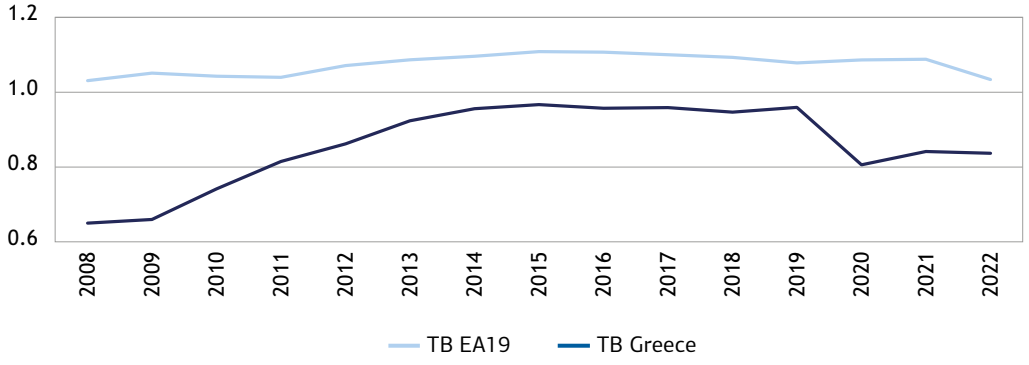
Source: Eurostat.

Figure 3.1.6 Trade-balance ratio (TB), based on services, of Greece and the EA19



Source: Eurostat.

Figure 3.1.7 Trade-balance ratio (TB) of Greece and the EA19



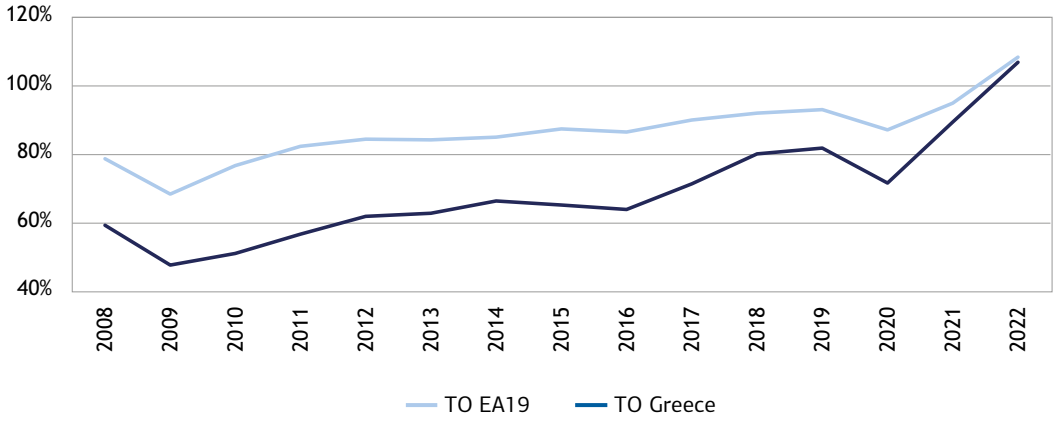
Source: Eurostat.

First, we notice that the TB ratios for the EA19 are slightly greater than 1 (ranging from 1.01 to 1.13), denoting a trade surplus. On the other hand, Greece faces a trade deficit in goods as *TB* takes values around 0.6, especially from 2013 onwards. When it comes to the services, Greece overshoots the EA19 as the Greek TB ratio is 1.9 on average, denoting that exports are on average 90% greater than the imports, whilst the average *TB* for the EA19 is just 1.07. An exception was in 2020 where the Greek TB ratio took a value of 1.44, i.e., the value of exports of services was 44% larger than that of imports. The large values of Greece's TB ratio are driven mainly by the flourishing tourism sector.[10]

Regarding the TB ratio based on both goods and services (total value of exports over total value of imports), we observe, first, that the EA19 is a net exporter as *TB* takes values higher than 1, particularly between 1.03 and 1.11 (see Figure 3.1.7 above). Second, Greece is a net importer because its TB ratio has been lower than 1 during the period under consideration. From 2008 to 2014, the Greek TB ratio steadily increased, denoting that the growth of total exports' was larger than that of total imports. It appears that such a "*TB* rally" was driven by services, and more specifically, by the tourism sector given that travel receipts almost doubled in absolute terms (from €9.6 billion in 2009 to €18.1 billion in 2019) from 2009 to 2018 and more than doubled as percentage of GDP during that period.[11] Additionally, Greece enjoyed *TB* values very close to 1 during the period 2014-2019. Finally, in 2021 and 2022 the total value of exports was about 84% of the total value of imports, presenting a TB ratio almost identical to that of 2012.

Next, Figure 3.1.8 shows the trade openness (TO) of Greece and the EA19, based on both goods and services. *TO* is defined as the sum of export and import values, standardised with nominal GDP.

Figure 3.1.8 Trade openness (TO), based on goods and services, of Greece and the EA19



Source: Eurostat.

10. According to *Statista* <https://www.statista.com/statistics/644573/travel-tourism-total-gdp-contribution-greece/>, the total contribution of travel and tourism to GDP in Greece was about 37.8 billion euro in 2022 (about 18.2% of the GDP).

11. See Rodousakis and Soklis (2022).

TO is used to quantify the openness of a given country and could be seen as a degree of globalisation of the country under consideration. One can notice that in 2022, both Greece and the EA19 enjoy for the first time a larger than 100% *TO* during the period under consideration. Also, from 2017 to 2022, *TO* exhibits values larger than the historical average of the examined period for both Greece and the EA19. Moreover, Greece's deviation from the EA19 was about -22 pp, on average, during the period 2008-2016. However, from 2017 onwards, the *TO* gap has been progressively closing –with an exception in 2020, the first year of COVID-19– and eventually in 2022, there is almost convergence (gap takes value of -1.5 pp) for Greece and the EA19, in terms of trade openness.

3.2. Cost/price competitiveness indices

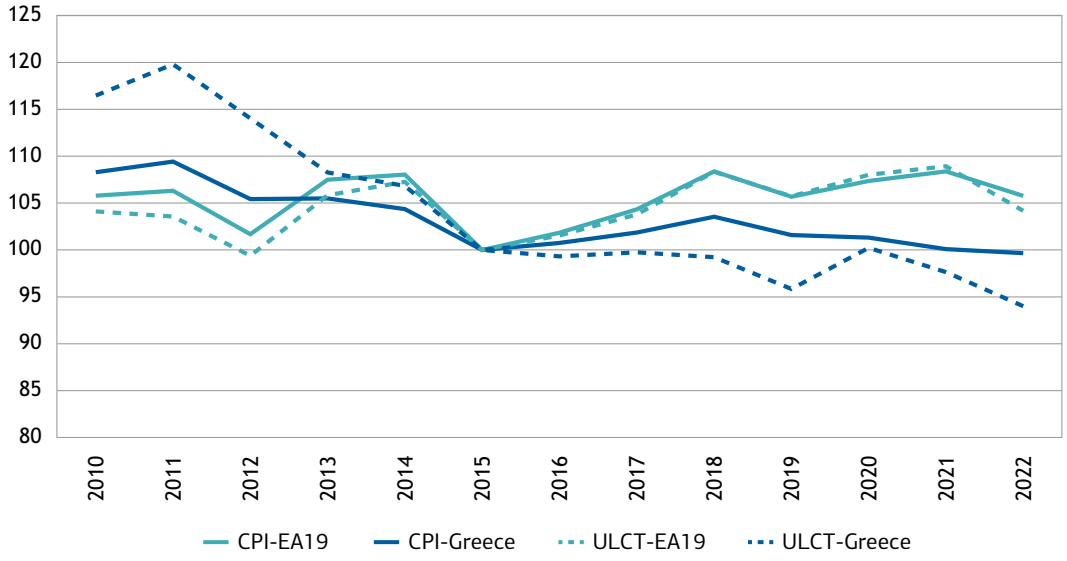
Among the most commonly used cost/price competitiveness indicators is the Real Effective Exchange Rates (REERs). The main purpose of REERs is to depict a country's price/cost competitiveness relative to its principal competitors. REERs are usually calculated using as a deflator either the consumer price index (CPI) or the unit labour cost in the total economy (ULCT). As far as Greece is concerned (Figure 3.2.1), the CPI-based REER slightly decreased in 2022 for the fourth consecutive year, whereas the ULCT-based REER, which significantly increased in 2020, decreased in 2022, for the second consecutive year, reaching its lowest point for the period under consideration (2010-2022). These decreases imply a further improvement of Greece's trade competitiveness.

As far as the EA19 and the EU27 are concerned, both indices decreased in 2022, compared to the previous year, for the first time after two years of increases, indicating that the competitiveness of the EA19 and the EU has started to ameliorate. It should be noted that the results are not uniform. Sixteen member states recorded a decrease in the CPI-based REER, and the remaining eleven member states recorded an increase (Sweden and the Czech Republic experienced the highest decrease and increase, respectively). Moreover, eighteen member states recorded a decrease in the ULCT-based REER, and the remaining nine member states recorded a decrease (Ireland and Bulgaria experienced the highest decrease and increase, respectively).

Moreover, the nominal unit labour cost (ULC) (on hours worked) that increased dramatically in Greece in 2020, compared to 2019, decreased significantly in 2021 and further decreased in 2022 (Figure 3.2.2). On the contrary, the ULC continued to increase in the EA19 and the EU27. In 2020, the ULC increased significantly, while in 2021, the increase was milder and, again, in 2022, the increase reached almost the same level with the one recorded in 2020, for both the EA19 and the EU27. The only member states that exhibited a decrease in ULC in 2022, compared to 2021, are Greece and Ireland.

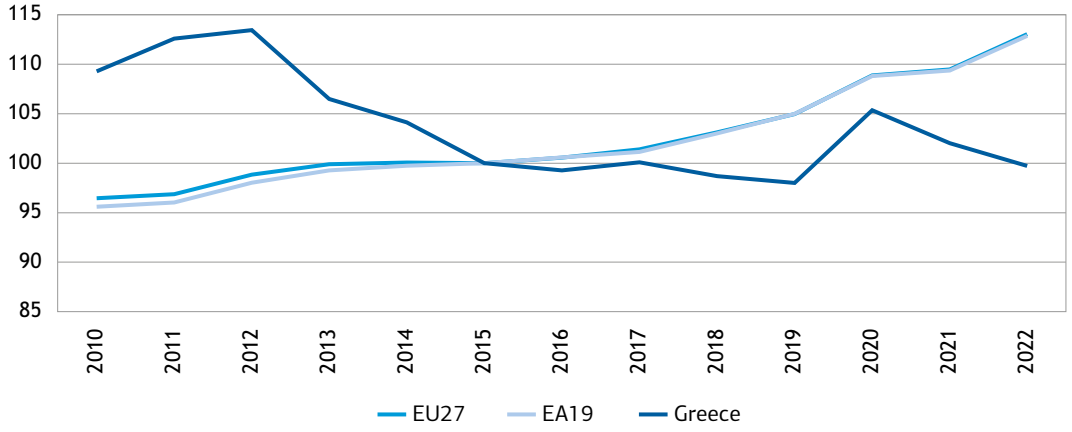
Furthermore, the relative unit labour cost, which measures the trading position of Greece relative to its EA partners, decreased by 1.7 p.p. in 2022, compared to 2021 (the seventh largest decrease recorded among the EU27 member states), verifying the amelioration of Greece's competitive position relative to its EA19 partners. Greece is among the 14 EU27 member states that exhibited a decrease in relative unit labour cost.

Figure 3.2.1 Real Effective Exchange Rates (37 trading partners, 2015=100)



Source: Eurostat.
Note: 37 trading partners are selected, i.e., the EU27 and 10 other countries (Australia, Canada, Japan, Mexico, New Zealand, Norway, Switzerland, Turkey, United Kingdom, the USA).

Figure 3.2.2 Nominal unit labour cost based on hours worked (2015=100)



Source: Eurostat.

As the economies recover from the repercussions of the COVID-19 pandemic, the surge in energy prices and other risks stemming from the conflict in Ukraine pose additional challenges. Although Greece was among the economies that were most severely hit by the pandemic, and was greatly affected by soaring energy prices, with headline inflation reaching a record high 9.3% in 2022 (EC 2023), it appears to be on a steady path to recovery. Nevertheless, investments and reforms aiming to improve the productivity, competitiveness and resilience of Greece's economy are vital and of the utmost importance.

3.3. Regional competitiveness

Regional competitiveness can be defined as the "ability of a region to offer an attractive and sustainable environment for firms and residents to live and work" (Dijkstra et al., 2023), focusing on the balance between entrepreneurial success and societal well-being. The EU Regional Competitiveness Index (RCI) 2022[12] is composed of 68 indicators (of which 48 are at the regional level) grouped into 11 pillars, which are organised into three sub-indices: a) basic (institutions, macroeconomic stability, infrastructures, health, and basic education), b) efficiency (higher education, training, and lifelong learning, labour market efficiency, and market size) and c) innovation (technological readiness, business sophistication and innovation). Each sub-index is weighted differently according to the development stage of the region,[13] and the EU average for each sub-index and pillar is 100.

As it becomes evident from Table 3.3.1, Greek regions reside at the end of the scale, while two Greek regions reside at the bottom ten regions of the RCI index (Anatoliki Makedonia, Thraki and Sterea Ellada). By comparing the RCI 2022 with the previous editions of the index, it is observed that seven regions improved their position compared to 2019 and 2016, while Dytiki Ellada and Anatoliki Makedonia, Thraki improved their position compared to 2019, but deteriorated compared to 2016. The ranking of the remaining four regions (Voreio Aigaio, Ionia Nisia, Notio Aigaio and Sterea Ellada) worsened in 2022 compared to both 2019 and 2016. The sharpest decline is observed in Notio Aigaio (which dropped 10 places compared to 2019 and 13 places compared to 2016). Furthermore, most Greek regions perform similarly to their peer regions (15 regions with similar GDP per capita). Notio Aigaio and Sterea Ellada are the only regions that underperform compared to their peers.

Similar to most of the EU member states, Greece's capital region (Attiki) performs significantly better than the other regions of the country in all sub-indices and in almost all pillars (the health pillar is the only exception). It should be noted that Attiki is also the only transition region in Greece, while all other regions are less developed regions. As Dijkstra et al. (2023) point out (based on the classification of regions by stage of development), there is a link between development and competitiveness, as more developed regions perform better than transition and less developed regions, and transition regions perform better than less developed regions.

Nevertheless, Attiki scores above the EU average only in the Innovation sub-index (102.7), while it performs close to the EU average in the Efficiency sub-index (98.8) and well below in the Basic sub-index (72). It also performs above the EU average in four (out of eleven) pillars (infrastructure, health, higher education and lifelong learning, and business sophistication). Especially as far as the business sophistication pillar is concerned, Attiki performs significantly above its peer regions average and the EU average (Figure 3.3.1).

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12. The 2022 edition of the RCI has maintained the structure of the previous editions but an improved framework has been applied. The indices for 2019 and 2016 have been recalculated using the new methodology.

13. EU regions are grouped into three development stages according to their average 2018-2020 GDP per capita in PPS (purchasing power standards). Attiki is characterised as a transition region (Stage 2), while all the remaining regions are less developed (Stage 1).

Based on the national average of RCI 2022, Greece scores 73.1, significantly below the EU average, and ranks 25th, above Bulgaria and Romania. As illustrated in Figure 3.3.2, Greece has remained below the EU average in all three sub-indices, during the years under examination (2022, 2019, 2016) and scores above the EU average only in two pillars, i.e., the health pillar (for the years 2022 and 2016) and the business sophistication pillar (for all three years under examination). Nevertheless, Greece improved its score in the overall index and in two sub-indices (basic and innovation) in 2022, compared to 2019. Similar improvements have been recorded in most of the pillars, with the only exceptions being the labour market efficiency pillar and the market size pillar. In 2022, the lowest scores (below 50) are observed in the macroeconomic, market size, and technological readiness pillars.

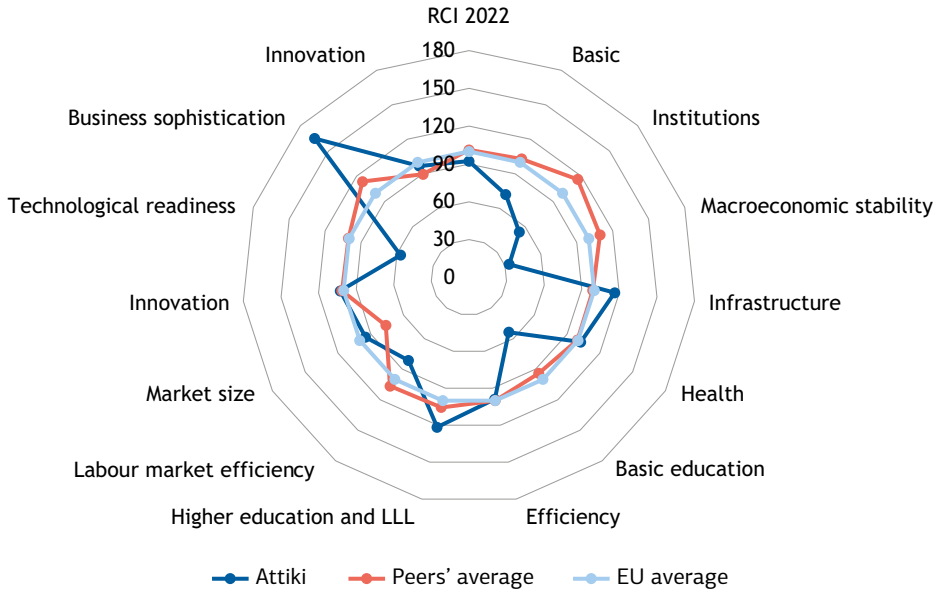
Concluding, the challenges posed by climate change, technological advancements, demographic changes, geopolitical conflicts, and the transformation of globalisation may have asymmetric implications across regions within a country. The recent crises of the COVID-19 pandemic and the war in Ukraine have underscored and exacerbated pre-existing territorial inequalities (OECD, 2021; 2022). Therefore, it is imperative to build resilient regions in order to effectively address present crises and proactively anticipate and prepare for potential unforeseen disruptions.

Table 3.3.1 RCI 2022 ranking of Greek regions (out of 234)

Regions		Sub-indices			RCI 2022	RCI 2019	RCI 2016
		Basic	Efficiency	Innovation			
EL30	Attiki	*201*	108	98	134	143	163
EL52	Kentriki Makedonia	210	194	**161**	199	203	206
EL61	Thessalia	209	*206*	**175**	208	218	209
EL43	Kriti	215	215	**163**	209	211	212
EL54	Ipeiros	219	207	201	213	217	213
EL65	Peloponnisos	213	212	202	215	221	221
EL53	Dytiki Makedonia	221	208	209	216	224	216
EL41	Voreio Aigaio	212	221	195	217	216	207
EL62	Ionia Nisia	*217*	213	207	218	213	210
EL63	Dytiki Ellada	*222*	*222*	184	220	225	218
EL42	Notio Aigaio	*218*	217	*222*	*224*	214	211
EL51	Anatoliki Makedonia, Thraki	220	*225*	211	225	*228*	*224*
EL64	Sterea Ellada	*214*	*231*	210	*228*	222	222

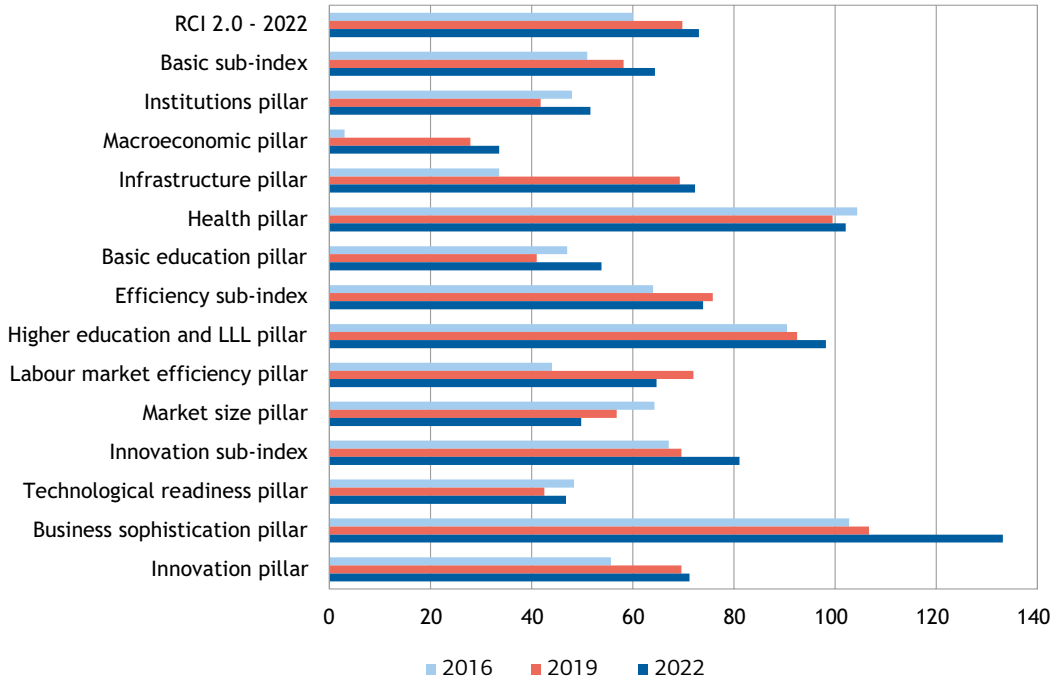
Source: EU Regional Competitiveness Index 2022, author's calculations.
Note: Blue fonts indicate the best performing region and red fonts indicate the worst performing region. Bold fonts indicate that the region overperforms with respect to its peers. Fonts in italics indicate that the region underperforms with respect to its peers.

Figure 3.3.1 RCI scores by sub-index and pillar for the region of Attiki, its peer regions' average and the EU average



Source: EU Regional Competitiveness Index 2022.

Figure 3.3.2 RCI scores by sub-index and pillar, Greece average



Source: EU Regional Competitiveness Index 2022.

3.4. Challenges and reforms for the digitalisation of businesses

3.4.1. Digital transformation challenges

The internet and digital technologies are transforming the economy and society, bringing about enormous growth potential and exerting a profound impact on productivity, employment, business models and public services. Across Europe and beyond, businesses are engaged in a rapid process of digital transformation, integrating digital technologies into all aspects of their operation, and taking advantage of newer technologies, such as innovative digital platforms, the internet of things, cloud computing and Artificial Intelligence. Digitalisation creates new opportunities and allows industries to produce new or existing goods and services in a more resource-efficient way. Therefore, digital transformation is increasingly becoming an important condition to thrive, particularly in sectors such as manufacturing, transport, energy, agri-food, telecommunications, and health care.

In the case of Greece, Digital Economy and Society (DESI) indices show that the integration of digital technologies into business activities has recorded significant progress in recent years, although challenges towards digital transformation remain considerable (see Greek NPB, 2022). As reported in a recent study by the Hellenic Federation of Enterprises (SEV, 2022), while significant private investments in digital systems are taking place in Greece, the digital maturity of the country's businesses remains low, showing limited adoption of new-generation digital systems (such as Artificial Intelligence), and a significant lag compared to other EU countries in the use of systems of moderate technological intensity (such as cloud computing). According to a relevant survey by the National Documentation Centre (EKT, 2022), the majority of businesses in Greece make use of digital technologies and consider digital transformation as an important and constant development strategy. However, at the same time, a large share of the business sector shows insufficient knowledge and understanding, particularly with respect to cutting-edge digital technologies such as Artificial Intelligence, blockchain technology and 3D printing.

Table 3.4.1 presents recent information on the digital intensity of enterprises in the main sectors of activity in Greece and the EU27, based on the Digital Intensity Index, a composite indicator derived from Eurostat's survey on ICT usage and e-commerce in enterprises. According to the relevant index values for the year 2022, the share of businesses featuring a very low degree of digital intensity presents great variation among the main sectors of economic activity, but is generally higher in Greece compared to the EU average per sector. Notably in manufacturing, the proportion of businesses reporting a high or very high level of digital intensity adds to a total of 14.7% in Greece, versus a respective EU average of 28.6%. This shortfall assumes particular importance because digitalisation is an integral part of progressing towards the smart and connected production systems of the fourth industrial revolution (Industry 4.0).

Table 3.4.1 Digital intensity of businesses in the main sectors of activity in Greece, and the EU27, 2022, % of enterprises

NACE_R2 activity	Very low digital intensity		Low digital intensity		High digital intensity		Very high digital intensity	
	Greece	EU-27	Greece	EU-27	Greece	EU-27	Greece	EU-27
Manufacturing	51.8	31.7	33.5	39.7	12.6	23.7	2.1	4.9
Electricity, gas, steam and air conditioning supply, water supply, sewerage, waste management and remediation activities	28.6	22.4	41.8	37.8	26.6	35.3	3.0	4.5
Construction	56.0	43.4	34.6	42.9	9.3	13.2	0.2	0.5
Wholesale and retail trade; repair of motor vehicles and motorcycles	45.8	24.9	27.2	38.0	23.6	30.7	3.5	6.4
Transportation and storage	43.7	39.6	28.7	37.4	26.6	20.2	1.0	2.8
Accommodation and food service activities	79.7	46.8	14.1	35.5	5.9	15.6	0.3	2.1
Information and communication	6.7	2.4	18.5	13.0	66.5	71.6	8.2	13.0
Real estate activities	20.9	13.7	33.7	40.4	41.8	43.0	3.6	2.8
Professional, scientific and technical activities	19.2	5.0	27.9	37.3	50.4	54.2	2.5	3.5
Administrative and support service activities	44.8	33.8	22.1	38.2	31.5	24.9	1.6	3.0
Information and Communication Technology	2.5	2.2	8.9	11.8	78.1	72.2	10.4	13.7

Source: Eurostat, 2023.

3.4.2. Strategy and reforms for the digitalisation of businesses in Greece

The digital transformation of Greece's business sector is promoted through the wider reform programme implemented to simplify the business environment, facilitate business activity, enhance the interaction of businesses with the public sector and encourage innovation. Furthermore, the digitalisation of businesses represents one of the four main axes of Greece's "Digital Transformation Bible 2020-2025" (Ministry of Digital Governance of Greece, 2021), a dedicated roadmap outlining the strategic goals and necessary interventions for the digital transformation of the Greek economy. The prioritisation of business digitalisation as one of the four main directions towards digital

transformation[14] is in line with the common European strategic targets and objectives set out in the EU's Digital Compass policy programme (European Commission, 2021c). According to this programme, by 2030, three out of four companies in the EU should use cloud computing services, big data and Artificial Intelligence; more than 90% of SMEs in the EU should reach at least a basic level of digital intensity; and the number of EU unicorns (start-ups valued at $1billion or more) should double.

In the case of Greece, the strategy towards the digitalisation of the business sector aims to increase the adoption of digital technologies by businesses, focusing particularly on reducing the digital gap between Greek SMEs and their EU counterparts. To this end, the annual National Reform Programme of Greece (Hellenic Republic, 2023) incorporates a set of reforms and investments that will support the digital awareness of businesses and help them build their digital infrastructure through the acquisition and implementation of digital tools and processes. Several of the flagship interventions pursued are part of the National Recovery and Resilience Plan-Greece 2.0 (RRP) and are therefore supported by the Recovery and Resilience Fund, while many other key projects are coupled with funding by the Partnership Agreement 2021-2017.

More specifically, as part of the RRP, important interventions include:

- The introduction of a legislative reform to provide tax incentives for businesses investing in their digital transformation.
- The implementation of projects aimed at linking academia and the productive sector by connecting research and innovation with entrepreneurship. Relevant projects include the participation in European Partnerships/Joint Undertakings for High Performance Computing and Key Digital Technologies (KDT-JU), the Research-Create-Innovate investment, funding 36 excellent project proposals, and the "HORIZON 2020 Seal of Excellence: financing top innovative companies" investment, providing Horizon 2020 grants to 13 awarded project proposals.
- The creation of the ELEVATE GREECE platform, a digital portal for accredited start-ups with features of innovation and scalability.
- The New Industrial Parks intervention, aiming at developing new generation industrial parks, through actions supporting the digital transformation and the creation of smart industrial areas.
- The Smart Manufacturing project, providing financial support to manufacturing SMEs for adapting to the needs of the digital and green transition.
- The Digital Transformation of the Agricultural Sector project, aimed at addressing the slow deployment of digital advanced technologies across the agri-food sector, through the development of large scale open digital infrastructure.

14. The other three directions of Greece's digital transformation strategy are the development of very high-capacity digital infrastructure and digital technologies, the improvement of digital skills and digitalisation of the public sector. For an overview of the strategy and relevant reforms, see Athanassiou, Kotsi, and Cholezas (2023).

- The "Digital transformation of SMEs", a three dimensional investment programme incorporating a) the "Digital tools for SMEs" programme, strengthening the digital maturity of SMEs in a wide range of economic sectors, b) the "Development of digital products and services" programme, supporting investment in the development of new products and services in the IT and communications sector, and c) the "Digital Transactions" programme, promoting the adoption of modern digital tools for invoicing, issuing and processing tax documents and making electronic payments.

Outside the RRP, important initiatives contributing to the digital transformation of businesses include the designing, preparing and validating a National Strategy for Research, Technological Development and Innovation; supporting projects such as the establishment of an Innovation District (CHROPEI); participating in important projects of common European interest for enhancing value chains in critical sectors such as the health sector; undertaking initiatives and actions linking research and innovation with entrepreneurship and creating collaborative structures; implementing the project of the Digital Transformation of the Greek Industry according to the national strategy for the promotion of Industry 4.0 for the years 2021-2027; and implementing a comprehensive National Strategy for Industry. Furthermore, in the framework of the Partnership Agreement 2021-2027, the programme "Competitiveness 2021-2027" provides for several actions regarding the basic, advanced and cutting-edge digital transformation of businesses.

3.5. Competitiveness indicators for digitisation and AI

3.5.1. Competitiveness indicators for digitisation

At the time of this writing, the Digital Economy and Society Index (DESI) has not yet been published. Hence, the present report uses the IMD world digital competitiveness rankings to show the degree of the digitisation of the Greek economy. Table 3.5.1 illustrates the digital competitiveness rankings for the years 2020, 2021 and 2022. The IMD collects data for 63 economies and the table shows the rank of the Greek economy as well as the best performer for each of the criteria used by the IMD.

Despite the country's efforts on digitisation, which has accelerated, particularly during the pandemic, it is not improving when compared to other countries. There was some improvement up till 2021, but 2022 shows a deterioration of digital competitiveness. The IMD report includes a set of 25 EU countries. In the 2021 edition, Greece was 44th, ahead of Hungary (45th), the Slovak Republic (47th), Romania (50th), Bulgaria (52nd) and Croatia (55th). In the 2022 edition, Greece has fallen behind all 25 EU member states included in the report. Hungary (42nd), Croatia (43rd), the Slovak Republic (47th), Bulgaria (48th) and Romania (49th) have demonstrated a faster improvement of their digitisation. Croatia has achieved the greatest improvement (12 ranks), followed by Bulgaria (4 ranks) and Hungary (3 ranks), while Greece has fallen 6 ranks.

Table 3.5.1 Ranking of Greece according to the IMD World Digital Competitiveness 2020, 2021, 2022 (total number of countries: 63)

Factor	Rank			Best performer
	2020	2021	2022	
Total ranking	**46**	**44**	**50**	**Denmark**
Knowledge	***48***	***45***	***47***	***Switzerland***
Talent	*50*	*42*	*49*	*UAE*
Educational assessment PISA-Math	41	41	39	China
International experience [s]	47	19	39	Switzerland
Foreign highly skilled personnel [s]	58	52	57	Switzerland
Management of cities [s]	46	48	44	UAE
Digital/Technological skills [s]	41	36	47	Iceland
Net flow of international students	51	54	51	UAE
Training and Education	*56*	*55*	*59*	*Kazakhstan*
Employee training [s]	56	44	54	Denmark
Total public expenditure on education	44	44	43	South Africa
Higher education achievement	31	34	32	Kazakhstan
Pupil-teacher ratio	57	59	58	Japan
Graduates in Sciences	10	15	18	Hong Kong
Women with degrees	36	35	36	Kazakhstan
Scientific concentration	*36*	*35*	*33*	*USA*
Total expenditure on R&D (%)	35	31	28	Israel
Total R&D personnel per capita	28	27	26	Taiwan
Female researchers	28	28	23	Venezuela
R&D productivity by publication	33	33	32	China
Scientific and technical employment	25	20	13	Canada
High-tech patent grants	45	47	47	Singapore
Robots in Education and R&D	39	39	38	China
Technology	***43***	***46***	***47***	***Singapore***
Regulatory framework	*41*	*43*	*42*	*Singapore*
Starting a business	6	6	6	New Zealand
Enforcing contracts	59	60	59	Singapore
Immigration laws [s]	15	23	27	UAE
Development & application of technology [s]	47	36	45	Denmark
Scientific research legislation [s]	40	43	44	Switzerland
Intellectual property rights [s]	45	45	41	Finland

Table 3.5.1 (continued)

Factor	Rank			Best performer
	2020	2021	2022	
Technology (continued)				
Capital	*49*	*52*	*46*	*India*
IT & media stock market capitalisation	11	14	13	Taiwan
Funding for technological development [s]	50	41	44	Finland
Banking and financial services [s]	60	58	57	Denmark
Country credit rating	57	57	55	many
Venture capital [s]	57	49	49	Sweden
Investment in Telecommunications	11	22	22	India
Technological framework	*46*	*50*	*50*	*Hong-Kong*
Communications technology [s]	50	51	48	Finland
Mobile Broadband subscribers	40	41	47	Taiwan
Wireless broadband	40	32	30	UAE
Internet users	40	52	50	UAE
Internet bandwidth speed	51	49	51	Singapore
High-tech exports (%)	32	32	31	Hong-Kong
Future readiness	***46***	***43***	***60***	***Denmark***
Adaptive attitudes	*44*	*43*	*60*	*Korea Rep.*
E-Participation	41	41	39	Estonia, Korea Rep., USA
Internet retailing	29	33	33	Korea Rep.
Tablet possession	41	41	39	Bahrain
Smartphone possession	48	49	59	Hong-Kong
Attitudes toward globalisation [s]	48	45	41	Sweden
Business agility	*55*	*51*	*61*	*Denmark*
Opportunities and threats [s]	47	42	48	Denmark
World robotics distribution	44	44	43	China
Agility of companies [s]	57	51	52	Denmark
Use of big data and analytics [s]	57	45	62	USA
Knowledge transfer [s]	53	50	54	Switzerland
Entrepreneurial fear of failure	26	27	42	Kazakhstan
IT integration	*45*	*41*	*41*	*Denmark*
E-Government	37	37	37	Denmark
Public-private partnerships [s]	40	30	39	Denmark
Cyber security [s]	37	42	48	Qatar

Table 3.5.1 (continued)

Factor	Rank			Best performer
	2020	2021	2022	
Future readiness (continued)				
IT integration (continued)				
Software piracy	52	52	53	USA
Government cyber security capacity			35	Israel
Privacy protection by law content			35	Portugal

Source: IMD World Digital Competitiveness Ranking 2022.
Notes: [S] Survey data. Blue (Red): moving up (down) relatively to previous year.

One must take into consideration that (a) the IMD focuses on competitiveness issues and (b) one-third of the indicators used are measured by survey questionnaires. Red (blue) colour of rankings demonstrates a fall (rise) in the country's ranking compared with the corresponding ranking in the previous year's report. The Greek economy does not perform well in most of the 54 criteria. Thus, Greece must improve most of the criteria to reach the EU average.

However, there are some criteria that need particular attention. A first set of criteria are related to education and training, such as educational assessment PISA-Math, pupil-teacher ratio, employee training, digital/technological skills, attraction of foreign highly skilled personnel, and high-tech patent grants. The PISA tests take place every three years and Greece continuously loses ground. Moreover, the number of pupils per teacher has to decrease considerably. Employee training is not a high priority in Greek companies, digital and technological skills are not readily available, and the attraction of foreign highly skilled personnel is at low levels. Finally, the number of high-tech patent grants has to increase.

A second set of criteria refers to the regulatory framework, capital, and the technological framework. Contracts are weakly enforced in Greece, and this is related to the urgent need for justice reforms. Funding for technological development and venture capital is not easily available for business. This fact is mostly the result of the economic crisis, from which the banking system has not yet fully recovered from yet. Consequently, the banking and financial services as well as the country's credit rating are still considerably low. Moreover, the internet bandwidth speeds must increase, and communications technology needs to better meet business requirements.

The last set of criteria refers to future readiness and includes adaptive attitudes, business agility and IT integration. What Greece needs to focus on is to improve the agility of companies and the use of big data and analytics, which according to the IMD, decreased in 2022. Knowledge transfer between companies and universities needs to accelerate, public-private partnerships supporting technological development must increase, and finally, cyber security and software piracy are issues that need immediate improvement.

3.5.2. Competitiveness indicators for AI

In an effort to capture the progress and impact of AI, the OECD has been publishing on-line data on AI for many countries. Table 3.5.2 illustrates AI research as captured by the number of AI publications per million population (to make data comparable among EU27 member countries) compared to the number of total scientific publications. The number of publications is cumulative during the 2000-2022 period. Greece has a relatively good score for publications in AI (ranking 12th), which is the result of a high AI publication percentage (12.7%) of all publications. This is the fifth highest percentage behind Cyprus (16.4%), Romania (15.8%), Malta (14.3%) and Belgium (13.7%). Based on the number of total publications per million population, Greece ranks 18th.

Table 3.5.3 demonstrates the AI software development as measured by contributions to public AI projects and project impact. The table shows the number of public AI projects and the number of high impact projects per million population for the years 2020, 2021 and 2022. It is encouraging that Greece, in 2022, is above the EU average in the number of all projects. However, regarding the number of high impact projects, its position falls below the EU average.

Table 3.5.4 shows the cumulative venture capital (VC) investment in AI from 2012 till 2021 and 2023, respectively, in order to offer a better view to the reader of the evolution of investments in AI during the last 2 years. This table also presents the per capita GDP of each country. Data for per capita GDP has been taken from the World Bank.[15] Additionally, the table shows the per capita VC investments in each country. It is evident that the Greek economy significantly lacks VC investments in AI. In 2021, the cumulative 2012-2021 per capita amount of VC investments in AI was just $1.8, giving Greece the 26th rank among the EU27. This number slightly increases to $2.7 in 2023, that is, in 2022 and 2023, the extra amount of VC investment in AI was just $0.9 per person, which places Greece last among the EU27. Even countries with lower per capita GDP, such as Bulgaria, Croatia, Hungary, Poland, and Romania (2022 data), invested considerably more in AI and significantly increased their VC investments during the last two years.

To get a better picture of the EU27, Table 3.5.4 also includes the USA, Israel, and China. Israel is the global leader in the cumulative per capita VC investments in AI ($1,732 per person in 2023). The USA is by far the heaviest investors in AI (a cumulative amount of $461.4 billion during the period 2012-2023), followed by China ($221.5 billion). Although Europe lags significantly behind, it seems to have increased its investments in the last two years by almost 73%; thus, its cumulative VC invested amount is expected to be $51.2 billion at the end of 2023, up from 29.6 billion in 2021.

15. <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>

Table 3.5.2 Publications (all and AI) per million population (cumulative 2000-2020)

	Country	All publications	AI publications	AI as % of all
1	Luxembourg	87,614	9,378	10.7
2	Finland	74,692	9,163	12.3
3	Belgium	65,103	8,918	13.7
4	Denmark	94,787	8,640	9.1
5	Sweden	80,706	7,809	9.7
6	Netherlands	67,014	7,281	10.9
7	Cyprus	40,981	6,716	16.4
8	Ireland	63,649	6,614	10.4
9	Slovenia	56,656	6,611	11.7
10	Austria	54,806	5,811	10.6
11	Portugal	42,905	4,798	11.2
12	**Greece**	**34,764**	**4,415**	**12.7**
13	Germany	42,496	4,333	10.2
14	France	49,017	4,309	8.8
15	Estonia	41,753	4,007	9.6
16	Spain	39,950	3,748	9.4
17	Italy	34,932	3,734	10.7
18	Czech Republic	33,029	3,680	11.1
19	Malta	24,519	3,506	14.3
20	Slovakia	23,778	2,565	10.8
21	Croatia	36,259	2,550	7.0
22	Lithuania	22,030	2,479	11.3
23	Hungary	19,113	2,317	12.1
24	Poland	27,506	2,240	8.1
25	Latvia	18,127	2,058	11.4
26	Romania	11,259	1,777	15.8
27	Bulgaria	13,253	1,439	10.9

Source: OECD <https://oecd.ai/en/data?selectedArea=ai-research>.
Blue: countries with better performance than Greece.

Table 3.5.3 AI software development per million population

Country	2020	2021	2022	Country	2020	2021	2022
	All projects				High impact		
Ireland	341	244	177	Denmark	4.3	4.9	1.9
Denmark	126	117	115	Estonia	3.5	1.6	1.6
Sweden	136	130	109	Netherlands	5.8	3.8	1.4
Finland	130	116	107	Germany	4.6	2.7	1.1
Netherlands	123	113	103	Sweden	4.3	2.9	0.8
Portugal	69	113	103	Austria	4.2	2.7	0.8*
Estonia	88	65	91	France	2.5	1.7	0.7
Germany	94	85	84	Slovenia	4.9	1.5	0.7
Greece	**66**	**75**	**76**	**EU27**	**2.8**	**1.6**	**0.7**
France	79	73	70	Belgium	3.2	1.9	0.6
EU27	**73**	**68**	**66**	Ireland	7.8	2.8	0.6
Spain	70	67	66	Spain	2.2	1.3	0.5
Cyprus	57	51	66	Italy	1.7	0.9	0.5
Slovenia	47	52	58	**Greece**	**2.0**	**1.6**	**0.5**
Italy	44	49	56	Romania	0.7	0.5	0.4
Austria	64	55	55	Poland	1.4	0.5	0.4
Belgium	60	59	53	Lithuania	1.6	0.0	0.4
Poland	53	41	46	Slovakia	1.5	0.1	0.4
Czech Republic	38	33	32	Finland	4.8	1.6	0.3
Croatia	35	32	32	Czech Republic	2.3	1.0	0.3
Lithuania	35	43	29	Croatia	0.4	0.5	0.3
Hungary	21	22	25	Hungary	0.6	0.4	0.2
Latvia	25	16	25	Bulgaria	0.5	0.3	0.1
Romania	35	28	22	Portugal	2.1	1.1	0.1
Bulgaria	24	18	21	Cyprus	0.1	0.1	-
Slovakia	21	19	16	Latvia	0.0	0.0	-
Malta	-	-	-	Malta	-	-	-
Luxembourg	-	-	-	Luxembourg	-	-	-

Source: OECD <https://oecd.ai/en/dashboards/countries/Greece>.
Note: * Ranking is based on the second decimal number, not shown in the table.
- No data.

Table 3.5.4 VC investments in AI per capita (cumulative 2012-2023 in million $)

Country	GDP p.c.	2021	2023	$ p.c.21	$ p.c.23[1]
Israel	54,659	11,208	16,542	1,173.5	1,732.0
USA	76,398	310,410	461,433	931.4	1,384.5
Sweden	55,873	1,075	6,594	102.5	628.8
Estonia	28,332	169	428	125.7	318.2
Austria	52,131	1,450	2,204	160.3	243.7
Ireland	104,038	569	1,090	111.9	214.3
Germany	48,432	12,812	17,752	152.4	211.1
France	40,963	6,843	11,457	100.7	168.6
Denmark	66,983	641	969	108.6	164.2
China	12,720	183,394	221,471	129.9	156.8
Finland	50,536	513	752	92.3	135.3
EU27	37,149	29,629	51,156	66.1	114.1
Belgium	49,583	778	1,247	66.7	106.9
Portugal	24,274	672	1,095	64.7	105.5
Cyprus	31,283	99	118	79.1	94.3
Spain	29,350	2,157	3,593	45.3	75.5
Luxembourg	126,426	22	55[2]	33.7	84.5
Netherlands	55,985	798	1,306	45.1	73.8
Slovakia	21,258	80	230	14.7	42.3
Romania	15,892	107	568	5.6	30.0
Hungary	18,463	102	214	10.5	22.1
Malta	33,940	11	-	21.0	-
Czech Republic	27,638	79	195	7.5	18.5
Lithuania	23,433	27	45	10.0	16.7
Italy	34,158	388	825	6.6	14.0
Croatia	18,413	36	48	9.3	12.5
Slovenia	29,457	9	19*	4.3	9.0
Poland	18,321	161	304	4.3	8.1
Latvia	21,851	5	12	2.4	6.4
Bulgaria	13,772	8	39	1.1	5.7
Greece	**20,732**	**19**	**29**	**1.8**	**2.7**

Source: <https://oecd.ai/en/data?selectedArea=investments-in-ai-and-data&selectedVisualization=vc-investments-in-ai-vs-gdp-per-capita-by-country-over-time>
Notes: 1. Estimate.
2. 2022.
- No data.

3.6. Industry 4.0 technologies in Greece

The term Industry 4.0 is commonly used to denote the 4th industrial revolution and refers to a set of disruptive technologies applied to production and supply chain processes (Castelo-Branco et al., 2023; Teixeira and Tavares-Lehmann, 2022; Lu, 2017). Enabled by the development of Information and Communication Technologies (ICT), Industry 4.0 encompasses a rather wide range of advanced technologies, classified as physical (e.g., 3D printing and robotics), digital (e.g., cloud computing and big data) and biological (related to advances in research in biology, genetics and nanotechnology), the combination of which may transform an entire industry and its associated production, distribution and consumption systems (Teixeira and Tavares-Lehmann, 2022). While Industry 4.0 is considered to primarily apply to manufacturing, being grounded in the concept of the 'smart factory',[16] it can also be extended to other industries in the services domain (Castelo-Branco et al., 2023).

Irrespective of industry, new organisational business models and practices have emerged in the context of Industry 4.0 with positive effects on enterprises' operations and processes, translated into increased organisational efficiency, overall productivity, and long-term competitiveness (Horváth and Szabó, 2019). Enhanced integration of supply chain and production processes along with an improved flow of data promote firms' agility and flexibility and supply chains' resilience, creating opportunities to further innovation (Castelo-Branco et al., 2023; Teixeira and Tavares-Lehmann, 2022). However, several challenges and risks may occur, some of them related to the environmental impact of relevant technologies, making the actual contribution of Industry 4.0 to economic, socioenvironmental and energy sustainability questionable (Ghobakhloo, 2020; Williams, 2011).

In this context, the present section examines and evaluates the performance of Greek enterprises in adopting and using key Industry 4.0 technologies as compared to other EU27 enterprises. In addition, the relative performance of Greece is analysed with respect to environmental considerations related to the adoption, use and disposal of ICT equipment. The analysis uses Eurostat data[17] based on the 'Community survey on ICT usage and e-commerce in enterprises', which is conducted annually by the National Statistical Institutes of the member states.[18] For the purposes of our analysis, we focus on key indicators of ICT and Industry 4.0 technologies. The indicators are expressed as percentages of enterprises and refer to the most recent year for which corresponding data are available.[19]

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16. The 'smart factory' is usually conceptualised as a future state of a fully connected manufacturing system, mainly operating without human force by generating, transferring, receiving, and processing the necessary data to conduct all required tasks for producing all kinds of goods (Osterrieder, Budde, and Friedli, 2020).

17. Eurostat Database: <https://ec.europa.eu/eurostat/web/main/data/database>.

18. The survey population consists of enterprises with 10 or more employees. The financial sector is excluded.

19. The reference year may vary among the examined indicators since model questionnaires are subject to annual changes due to the evolving situation of ICT and the occasional focus of the survey on specific topics.

3.6.1. Use of Industry 4.0 technologies by Greek firms

Focusing first on the automation of core business processes, software solutions such as the Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM) play a prominent role in storing, analysing and managing business data, touching on multiple departments.[20] As shown in Figure 3.6.1, Greece appears to underperform in all relevant indicators referring to 2021. As far as the use of ERP software is concerned, almost 32% of Greek enterprises report that they use such software, with the corresponding figure for the EU27 being 38%. The gap is even larger, about 14 percentage points, in the case of two out of three examined CRM indicators (a general one referring to the use of any software solutions, such as CRM and a more specific one referring to the use of CRM to capture, store and make available client information to other business functions), where Greece ranks 21st among the EU27 member states. A slightly better performance is observed in the case of the use of CRM to analyse information about clients for marketing purposes, where Greece ranks 17th in the EU27, with 16.1% of Greek firms versus 19% of European firms[21] reporting the use of CRM for marketing purposes.

A critical enabler of Industry 4.0 and digital transformation is cloud technology, which provides the foundation for most advanced technologies, from artificial intelligence and machine learning to the Internet of Things. The Greek performance as compared to the EU27 for 2021 is measured by four Cloud Computing (CC)[22] indicators, including a general one which refers to the purchase of CC services used through the internet and three specific indicators capturing various CC services classified as basic,[23] intermediate[24] or sophisticated.[25] As shown in Figure 3.6.2, the performance of Greek enterprises is rather poor in all related indicators. With respect to intermediate CC services, Greece possesses the last place in the EU27, with only 0.7% of Greek firms (versus 4.1% of European firms) reporting that they have purchased at least one of intermediate CC services. Moreover, Greece appears to have the third worst performance after Romania and Bulgaria in terms of the general CC indicator and the one referring to sophisticated CC services, with the percentages of Greek firms purchasing either CC services in general (20.7%) or sophisticated CC services (14.5%) being almost half of the respective percentages of EU27 firms (41% and 29.8%).

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20. ERP is used to manage resources by sharing information among different functional areas (e.g., accounting, planning, production, marketing, etc.), while CRM helps in managing information about customers.

21. By 'European firms' we mean firms located in the EU27.

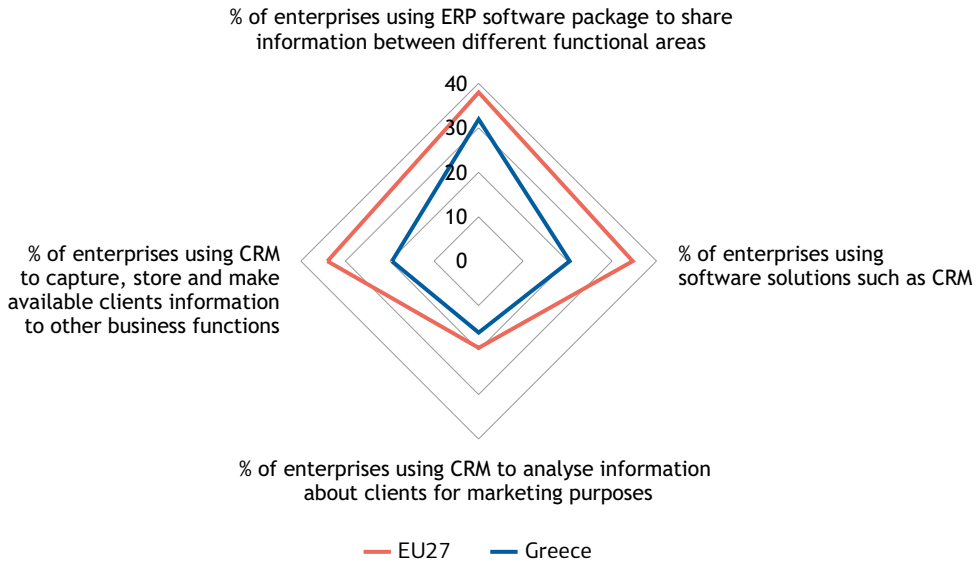
22. Cloud computing refers to ICT services that are used over the internet to access software, computing power, storage capacity, etc.

23. Basic CC services are defined in terms of buying e-mail, office software (e.g., word processors, spreadsheets, etc.), file storage or computing power to run the enterprise's own software as a CC service.

24. Intermediate CC services are defined in terms of buying finance or accounting software applications, ERP software applications or CRM software as a CC service.

25. Sophisticated CC services are defined in terms of buying security software applications, hosting for the enterprise's database or computing platform, providing a hosted environment for application development, testing or deployment as a CC service.

Figure 3.6.1 Use of ERP and CRM software: Greece and the EU27



Source: Eurostat.

Note: All indicators refer to the year 2021.

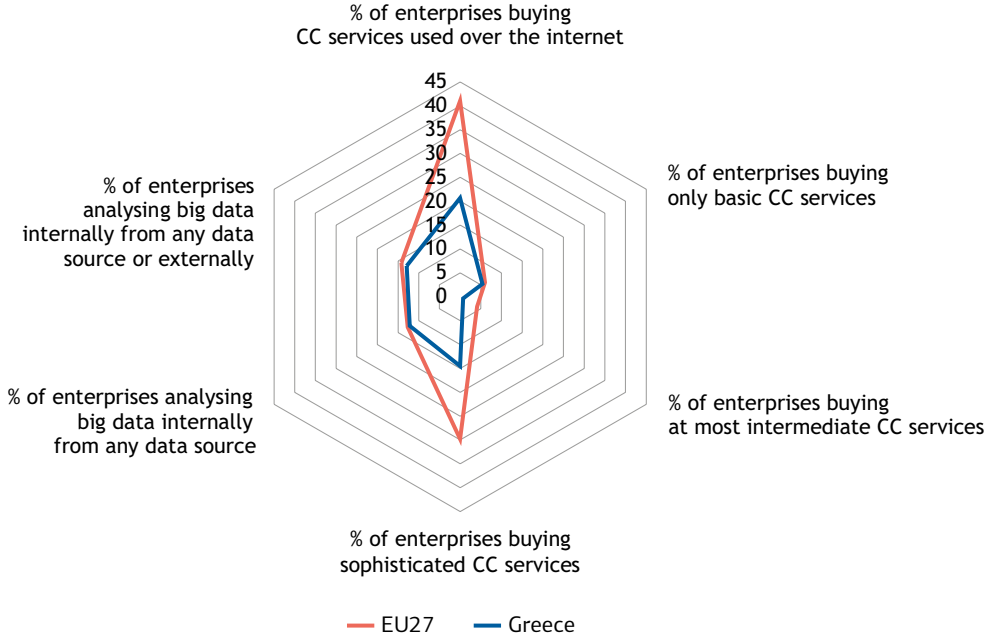
The data that fuels Industry 4.0 is commonly characterised by a big volume and a wide variety so as its collection and processing is a rather difficult task for traditional tools. From this perspective, big data analysis[26] is of utmost importance, since it enables fast and efficient management of constantly growing datasets coming from different sources. We examine two relevant indicators which refer to 2020: one capturing the internal conduct of big data analysis and the other referring to either internal or external conduct of big data analysis (see Figure 3.6.2). Although below the related figure for the EU27, the percentages of Greek firms who report internal (12.2%) and either internal or external big data analysis (12.9%) are not much lower than the corresponding firm percentages for the EU27 (12.7% and 14.2%), placing Greece in the 12th position among its EU27 counterparts.

Two additional revolutionary technologies of Industry 4.0 with a broad range of applications involve 3D printing[27] and autonomous robots, which offer huge potential to industrial production. As illustrated in Figure 3.6.3, only 0.7% of Greek firms (versus 2.2% of European firms) report that they use their own 3D printer, exhibiting the second worst performance in the EU27 after Cyprus. Slightly improved performance is observed in the case of using 3D printing services provided by other enterprises, with the respective figure for Greece being 1.3% versus 2.4% for EU27 (Greece

26. Big data analysis refers to the use of technologies, techniques or software tools such as data or text mining, machine learning, etc., for analysing big data extracted from enterprises' data sources or other data sources.

27. 3D printing or additive manufacturing is a process of making three-dimensional physical objects using digital technology.

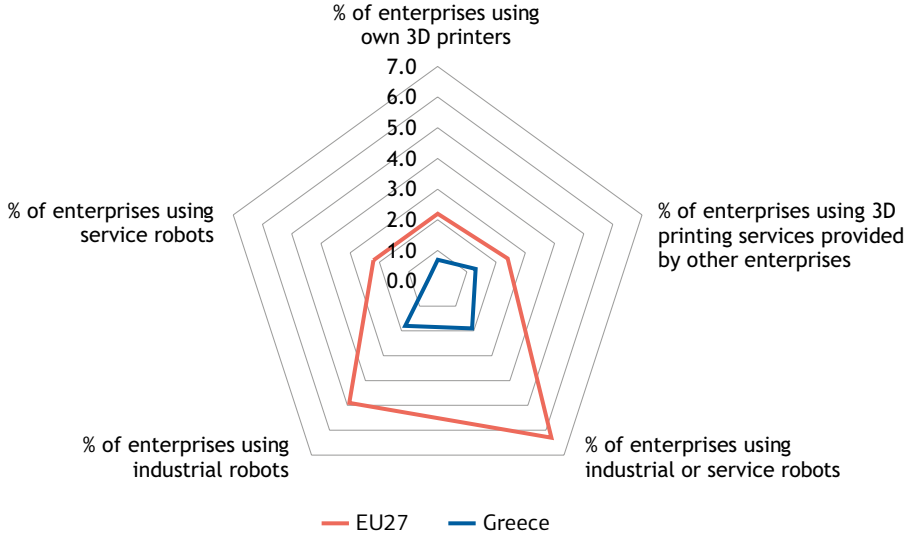
Figure 3.6.2 Use of Cloud Computing (CC) and big data analysis: Greece and the EU27



Source: Eurostat.

Notes: The CC indicators refer to the year 2021; the big data analysis indicators refer to year 2020.

Figure 3.6.3 Use of 3D printing and robots: Greece and the EU27



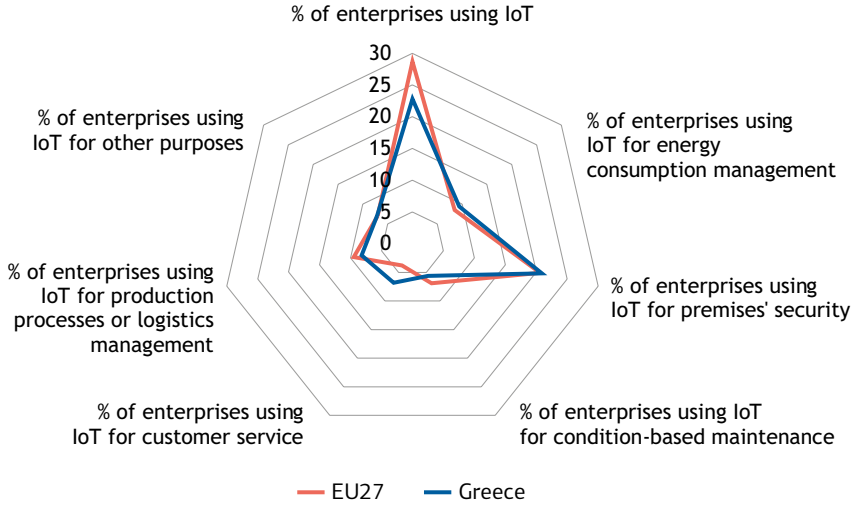
Source: Eurostat.

Notes: The 3D printing indicators refer to year 2018; the robot indicators refer to year 2022.

ranks 22nd). The picture is not better in the case of the three remaining indicators referring to the use of robots, i.e., industrial robots,[28] services robots[29] or both. Here Greece also appears to underperform, ranking second lowest among EU27 member-states after Cyprus. As shown in Figure 3.6.3, only 1.8% of Greek enterprises report the use of industrial robots, 0.3% the use of services robots and 1.9% the use of either industrial or services robots with the percentages of firms in the EU27 being 4.9%, 2.2% and 6.3%, respectively.

The Internet of Things (IoT), i.e., a network of interconnected devices or systems that can be monitored or remotely controlled via the internet, is another critical component of Industry 4.0 that unveils immense possibilities. IoT can be used for several purposes, such as energy consumption management, premises' security, condition-based maintenance, customer service, production processes, logistics management and others. As illustrated in Figure 3.6.4, 22.8% of Greek firms report the use of IoT, ranking 18th, while the corresponding figure for the EU27 is 28.7%. Firms in Greece use IoT mainly for premises' security (20.9% of Greek firms), which is also the most common purpose among EU27 member states (20.6% of European firms). Interestingly, 6.8% of Greek firms use IoT for customer service, while only 3.8% of European firms use it for the same purpose. As far as the remaining purposes for using IoT technologies are concerned, the percentage of Greek firms is close to that of the EU27.

Figure 3.6.4 Use of IoT: Greece and the EU27



Source: Eurostat.

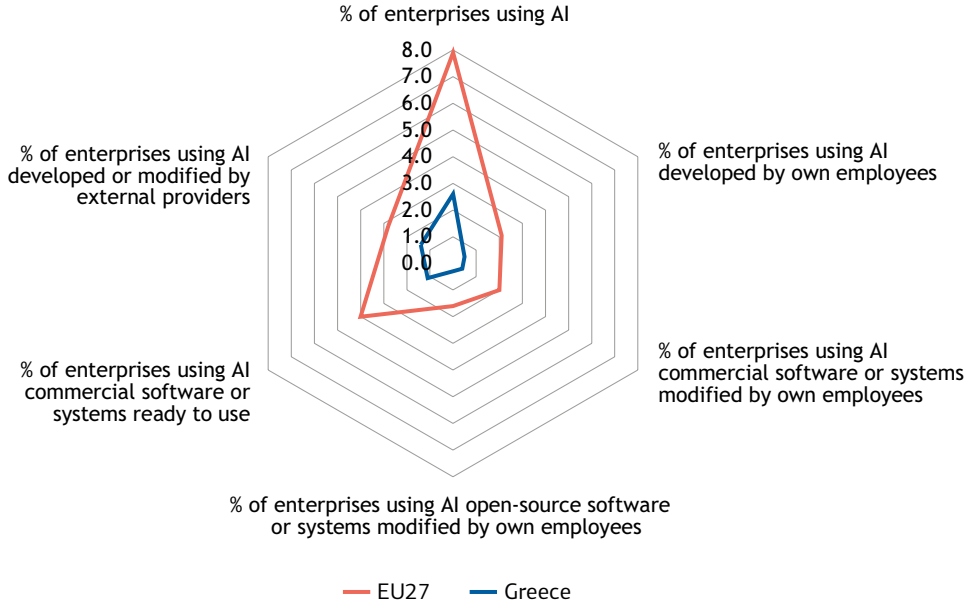
Note: All indicators refer to the year 2021.

28. An industrial robot is an automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications.

29. A service robot is a machine that has a degree of autonomy and is able to operate in complex and dynamic environment that may require interaction with persons, objects or other devices, excluding its use in industrial automation applications.

Artificial Intelligence (AI) has been emerging as one of the cornerstones of Industry 4.0, while almost every industry sector is pursuing AI-enabled solutions (Jan et al., 2023). Moreover, AI has a wide range of applications in the context of Industry 4.0. Firms adopt AI technologies for production processes, organisation of business administration processes, management of enterprises, logistics, ICT security, and human resources management or recruiting. However, the adoption of AI technologies is still rather limited in the EU27 and Greece, compared to other technologies, such as cloud computing and IoT. As demonstrated in Figure 3.6.5, only 7.9% of European enterprises have adopted AI technologies,[30] while the corresponding figure for Greece is only 2.6%. Greece ranks second from the bottom, along with Cyprus and just above Romania. At the other end, member states such as Denmark, Portugal and Finland make it to the top three, since more than 15% of the enterprises located in these countries use AI technologies (23.9%, 17.3% and 15.8%, respectively). It is worth noting, that European and Greek firms mainly use AI commercial software or systems ready-to-use (4% and 1.1%, respectively), or their AI solutions are developed or modified by external providers (2.8% and 1.4%, respectively). In addition, in-house development of AI technologies is limited to 2.1% of European firms and 0.5% of Greek firms. Furthermore, as illustrated in Figure 3.6.6, European firms use AI technologies mostly for

Figure 3.6.5 Use of AI: Greece and the EU27

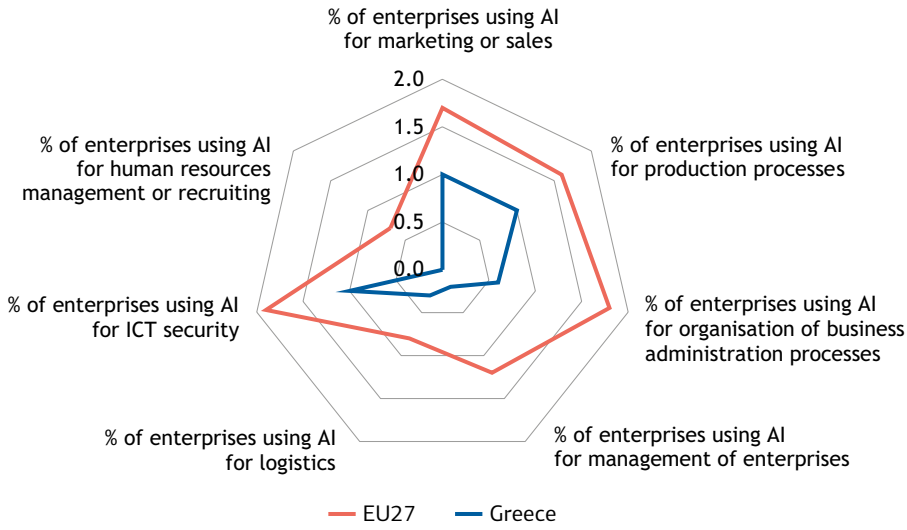


Source: Eurostat.

Note: All indicators refer to the year 2021.

30. Firms using at least one AI technology from the following: text mining, speech recognition, natural language generation, image recognition/processing, machine learning for data analysis, AI technologies automating different workflows or assisting in decision making, and AI technologies enabling physical movement of machines via autonomous decisions based on observation of surroundings.

Figure 3.6.6 Purposes for using AI: Greece and the EU27



Source: Eurostat.

Note: All indicators refer to the year 2021.

ICT security (i.e., 1.9% of European firms – 24% of European firms using AI) and for organisation of business administration processes (i.e., 1.8% of European firms – 23.5% of European firms using AI). Greek firms exhibit a rather different trend, since they mainly use AI technologies for production processes (i.e., 1% of Greek firms – 39.1% of Greek firms using AI) and for marketing or sales processes (i.e., 1% of Greek firms – 37.9% of Greek firms using AI).

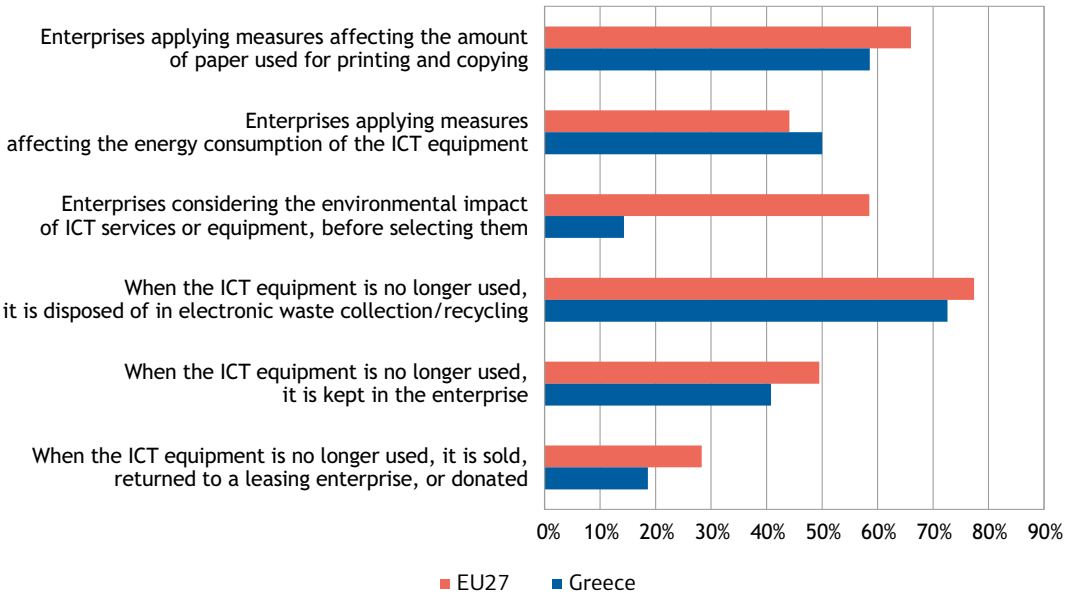
3.6.2. Industry 4.0 technologies and environmental considerations

The Digital and Green transitions may present both synergies and conflicts, as ICT can have both positive and negative impacts on the environment, turning the answer to the question of whether the Digital and Green transitions are compatible into a complex and often debatable issue (Zhang and Wei, 2022; Feroz, Zo, and Chiravuri, 2021). At the most direct level, on the one hand, ICT has a negative environmental impact through the use of energy and materials in the manufacturing of ICT equipment (Williams, 2011). In addition, the disposal of ICT equipment is another emerging problem, especially since e-waste is the fastest growing waste category.[31] On the other hand, ICT can contribute to pollution control, waste management and sustainable production (Feroz, Zo, and Chiravuri, 2021). Studies exhibit mixed results as to whether ICT leads to reduced energy demand and carbon emissions and mitigates climate change (Zhang and Wei, 2022).

To get a picture about how companies respond to environmental concerns over ICT, Figure 3.6.7 presents the percentage of firms applying measures that affect paper and energy use, taking into

31. Rolling Plan for ICT standardisation, <https://joinup.ec.europa.eu/collection/rolling-plan-ict-standardisation/ict-environmental-impact-rp2023>.

Figure 3.6.7 Environmental sustainability and ICT usage: Greece and the EU27



Source: Eurostat.

Note: All indicators refer to the year 2022.

consideration the environmental impact of ICT, and disposing of ICT equipment through three different streams (disposed of in electronic waste collection/recycling; kept in the enterprise; and sold, donated or returned to a leasing enterprise). Most European and Greek firms apply some measures affecting the amount of paper used for printing and copying (66% and 58.6%, respectively), while Greek firms seem to be more concerned about energy use than their European counterparts, since 50% of Greek firms apply some measures affecting energy consumption versus 44% of European firms. Astonishingly, only 14% of Greek firms consider the environmental impact of ICT services or equipment before selecting them versus 59% of European firms. As far as the disposal of ICT equipment is concerned, the most common mode of disposal is electronic waste collection/recycling (77% of European firms and 73% of Greek firms). Moreover, 50% of European and 41% of Greek firms keep certain ICT equipment that is no longer used and an even lower percentage of firms (28% of European firms and 19% of Greek firms) sell, donate, or return them to a leasing enterprise.

4. Thematic Productivity and Competitiveness Challenges

4.1. Income inequality and productivity

During the last two decades, income inequality has been identified as one of the most urgent socio-economic issues to be addressed, with multiple interlinkages affecting all major aspects of economic activity and its macroeconomic performance (Stiglitz, 2012). It has become commonly accepted that inequality not only undermines social cohesion, but also hinders economic growth (OECD, 2017). Numerous contributions to the literature on economic inequality offer insights into the social, economic, and political consequences of a divided society, arguing that reducing inequality and promoting shared prosperity initiatives are not only desirable, but also essential for the attainment of sustained economic development. Further support towards this claim is also found in the UN Sustainable Development Goals (UNDESA, 2015), that is, a list of high priorities seeking effective responses against the eradication of poverty in all its forms, with particular emphasis given to reducing inequalities within and between countries. Prosperity is directly associated with output per worker, leading to improved living standards. The rise of income inequality limits access to essential resources and opportunities, affecting well-being and eroding social cohesion, i.e., a state in which a growing fraction of the population is prevented from having access to basic needs such as education, healthcare, and other essential services. In the absence of an effective system of social protection, disadvantaged groups often face numerous barriers that impede their ability to improve their socioeconomic status.

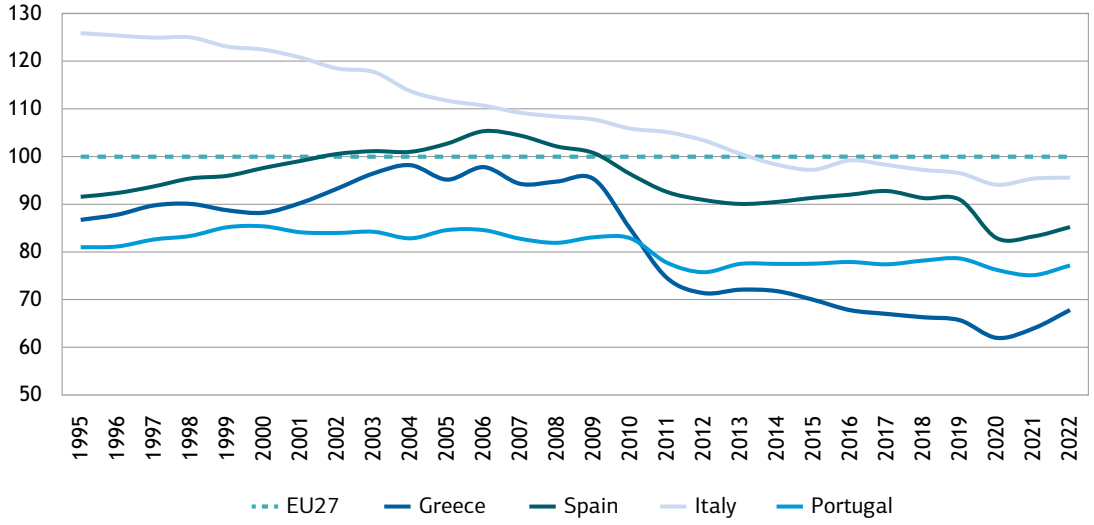
To a great extent, the relation between inequality and productivity is particularly pronounced in all social policies –national as well as regional– seeking to assist low- and middle-income households. On this account, the productivity-inequality nexus has been well documented and policy initiatives to strengthen aggregate demand through investments (OECD, 2016, Ch. 2) are considered vital for raising productivity and supporting living standards, especially of the most disadvantaged groups.

4.1.1. Greece's economy diverges from the EU average

Inequality among the EU countries is generally characterised by an upward trend. The EU is a diverse region with a wide range of variations in income levels across its member states and highly diversified production structures. Moreover, southern European countries show a particularly strong relative descending trend of income, which intensified after 2009. A rather simple concept, depicted in Figure 4.1.1, illustrates the level of disparity between the EU countries and provides a measure for understanding the trend of inequality.

Comparing the GDP per capita between Greece and the EU27 average (shown as 100 in Figure 4.1.1), it is concluded that the period of EU convergence comes to a halt or slows down following the 2009 downturn. Figure 4.1.1 depicts the long-term trends of the GDP per capita in PPS, as

Figure 4.1.1 GDP per capita, in PPS, as a percentage of the EU27 (100), major countries of southern Europe, 1995-2022



Source: Eurostat, Survey of Income and Living Conditions.

percentages of the EU27 (see Box 4.1.1), showing that in some countries, economic contraction was more severe than in others, highlighting the divergences among member countries.

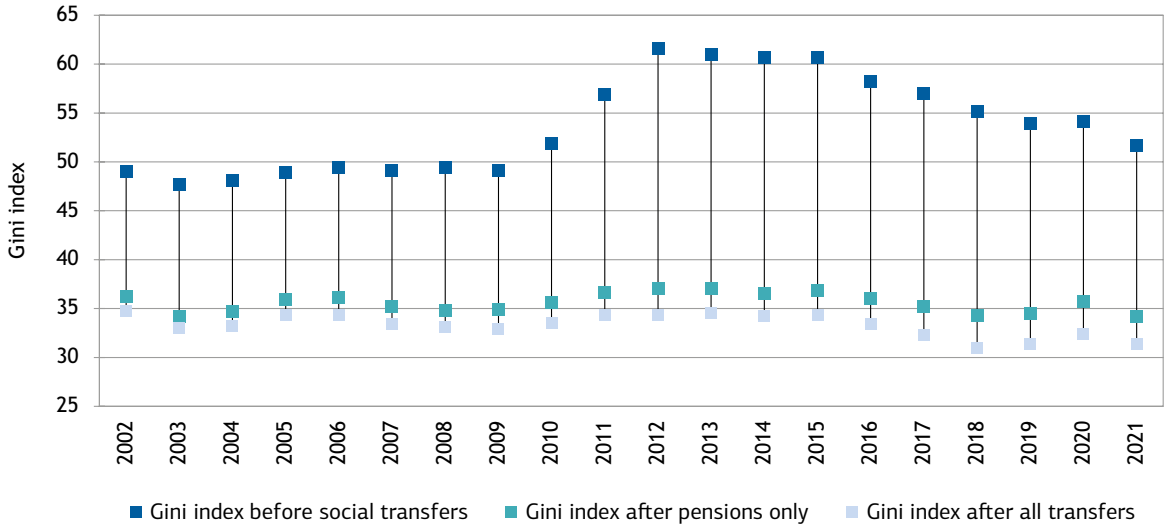
With all the major countries of the European south falling and diverging, Greece has scaled down at around 70% of the EU27 average. The distance between Greece and the EU27 has widened, and its GDP per capita in terms of purchasing power terms has remained stable at a low level for more than a decade. Since then, the country has faced serious challenges in achieving sustained growth and catching up with its European counterparts. This is crucial since country-regions where real GDP per capita is less than 75% of the EU27 average are eligible for support from the EU structural funds.

4.1.2. The Greek system of social protection suffers from chronic inefficiencies

In examining within country inequality, a chronic issue attributed to the physiognomy of the Greek system of social protection can be made apparent. Enhancing the effectiveness of social protection may be a very complex task. From this perspective, social welfare in Greece faces multiple challenges, that hinder its ability to provide adequate support to vulnerable groups (Missos, 2021a), perpetuating inequality and limiting the improvement of well-being. More equitable social protection in Greece remains an ongoing issue.

Three different Gini income inequality indices are presented in Figure 4.1.2 for the period between 2002 and 2021. The Gini index provides a concise measure of income inequality, and its calculation, as here presented, is based on the dispersion of disposable income. More specifically, the Gini index takes the value of 0 to indicate absolute equality (all individuals have the same income)

Figure 4.1.2 Gini before and after social transfers, 2002-2021, Greece



Source: Eurostat.

and that of 100 for the exact opposite, i.e., maximum inequality (all income is possessed by one individual). Increasing Gini indicates that a relatively smaller portion of the population holds a larger share of total income and, thus, it can be directly related to poverty and social exclusion.

As with all other countries of the EU, social transfers in Greece –along with other redistributive policies– contribute significantly towards reducing the unequal allocation of income. By providing financial support and essential services for health, education etc. to those with lower earnings or in need of assistance, social transfers contribute towards mitigating the effects of inequality and promoting social stability.

From 2010, the Gini index before all social transfers has gone through a rapid increase and the share of pensions seem to weigh more in redistributing income among the population. From 2002 to 2009, the share of pensions in reducing the Gini accounts for 13.6 points whereas, from 2010 to 2021, pensions contribute by more than 21 points, significantly higher than the EU27 average (15.4 points). The increasing trend of the Gini index before all social transfers implies that income gained through the operation of the market, such as wages, dividends, rents, and profits, shows a tendency towards a more unequal distribution. Social welfare systems can, thus, help offset inequality generated through the market and its efficiency depends on the adequacy to address the needs of the recipients by making evidence-based adjustments. Therefore, as income inequality becomes increasingly important over the years, the role of social protection is crucial in narrowing the gaps and ensuring access to basic services to promote social cohesion. A comprehensive approach that combines social protection with policies on growth, education and labour market opportunities could be more sustainable.

On the other hand, the rest of the social transfers (family benefits, unemployment benefits, etc.) seem to have only a minor effect on containing inequality. For example, the risk of poverty for

single-parent households in Greece is found to be higher compared to other household types (Missos, 2021b), requiring for a more targeted and specific strategy on social benefits. Recognizing the unique challenges faced by single-parent households means targeting the benefits toward the needs associated with raising children.

As far as the overall population is concerned, whereas the effectiveness of non-pension social transfers in decreasing inequality is improving, its relative performance is still quite low. Following the same line of argument, from 2002 to 2009, the average impact is estimated at 1.6 points, and from 2010 to 2021, it increases to 2.7 points, still half of the EU27 average. Such results are a clear indication that there is considerable room for reforms to improve the efficiency of social protection to mitigate income inequality and to ensure that social protection benefits can effectively reach and support those groups that are most in need. It should, thusly, be stressed that pensions comprise a large share of social benefits, suggesting that the Greek system of social welfare has been designed to address the needs of the elderly population with relatively less emphasis on other socio-economic groups.

4.1.3. Firm size and household income are positively related with productivity

The widespread recognition of the interconnections between productivity and inequality emphasises the role of better education, the application of cutting-edge technologies, and the acquisition of exclusive skills and specialised knowledge in advancing the range of capabilities and increasing the potential boundaries of the labour force (UNDESA, 2015, p.95-96; Hanson and Rose, 2010). Within this framework, more and better-quality jobs are considered as an essential driver to inclusive growth, on the condition that the introduced technological changes are labour augmenting, i.e., provide avenues for individuals to enter the workforce (OECD, 2018). Absorbing and applying new technological developments is, hence, highly essential since this creates the potential for higher wages, better benefits, and improved working conditions for employees.

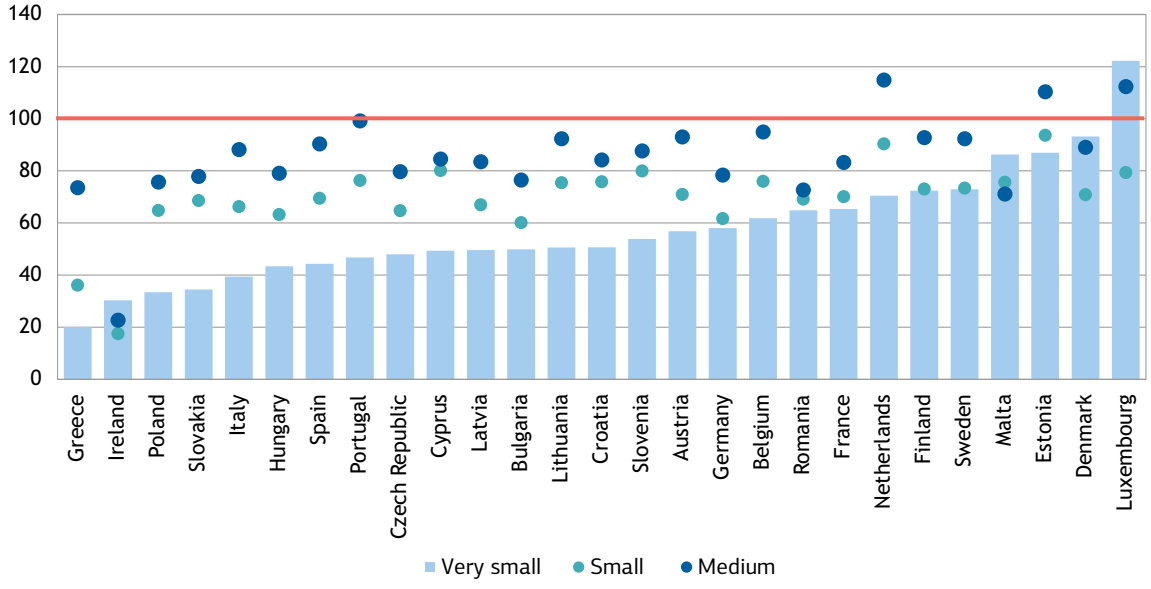
In terms of the number of enterprises, the production structure of entrepreneurial activity in Greece follows the general pattern of the EU27. According to the latest *Structural Business Statistics*[32] available, in 2021, very small enterprises (with less than 9 employees) in Greece account for 92.7% of total enterprises. Likewise, the EU27 average is estimated at 93.1%. These figures suggests that small-scale activity constitutes the backbone of the socio-economic fabric in Europe. SMEs are recognised as key contributors to growth and innovation and to generating employment, and they can rapidly absorb and employ a significant share of the total workforce. Yet, the number of employees working in very small enterprises in Greece corresponds to 40.1% of overall employment, well above the EU27 average of close to 28.5%. This result highlights the importance of small-scale entrepreneurial activity for income distribution and constitutes a crucial factor for further consideration in policy making.

32. *Structural Business Statistics,* Eurostat <https://ec.europa.eu/eurostat/web/structural-business-statistics>.

Figure 4.1.3 depicts the extent to which SME productivity (gross value added over number of employees) varies from that of large enterprises across the EU27 countries, indicated as 100. This divide is common, as large enterprises often have easier access to financial resources, advanced technologies, and human capital. All results in Figure 4.1.3 are in five-year averages spanning between 2017-2021. Despite the variety of approaches available, SMEs are here divided among very small (0-9 employees), small (10-49 employees) and medium (50-249 employees). The productivity level[33] of large enterprises (more than 250 employees) is demonstrated by the red horizontal line. The concept implies the productivity distance recorded between SMEs and large enterprises operating within the productive conditions prevailing in each country.

In comparing the productivity of SMEs and large enterprises (Figure 4.1.3), it is observed that very small businesses in Greece seem to perform well below that of any other country of the EU27. Moreover, small-size enterprises occupy the second lowest level, after Ireland, while medium-size enterprises maintain the third lowest place, behind Romania and Malta. The notably weak relative performance of SMEs in Greece reflects the relation between employment and production of

Figure 4.1.3 Comparing the productivity of SMEs and large enterprises (100), average 2017-2021, EU27



Source: *Structural Business Statistics* <https://single-market-economy.ec.europa.eu/smes/sme-strategy/sme-performance-review_en>.

33. From 2008-2014 and from 2015-2022, the average productivity levels of large-scale enterprises, measured in PPS as the ratio between gross value added and number of employees, shows a significant increase in variability among the EU27. More specifically, the coefficient of variation (CV) –the ratio of standard deviation to the mean– between the respective periods has almost doubled, indicating a greater dispersion of productivity performance.

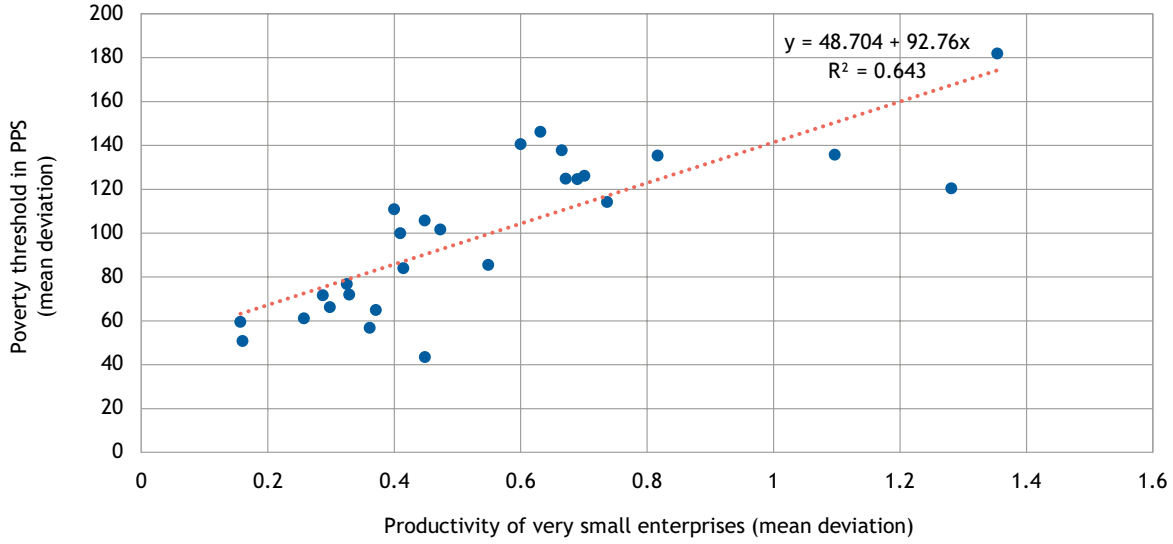
added value. This process is mediated by a wide range of different technical methods, along with the combination of knowledge-based techniques and highly advanced skills. As far as the very small-size enterprises are concerned, marginal improvements in their productivity level may have a strong effect on income, since the share of employment in that category is exceptionally high. Hence, in general, policies and initiatives aimed at enhancing skills, technology adoption, their innovation capacity and the general business infrastructure can help improve SMEs productivity. However, the effectiveness of such policy responses would primarily depend on the sectorial mix of the country's production structure and, what is more, on the concentration of either low or high value-added activities of which it is comprised.

In Figure 4.1.4, the correlation between productivity in very small enterprises and the poverty threshold in purchase power standard (PPS) is illustrated. To avoid occasional variations, all measures are taken as the five-year average (2017-2021) of mean deviations and the poverty threshold is calculated as 60% of the median disposable income, setting the boundary or "line" below which a person is considered "poor". Moreover, the vertical axis compares the poverty thresholds among the EU27 countries. Obviously, as shown in Figure 4.1.4, among the countries of EU27, the two variables seem to be positively correlated, indicating the importance of very small entrepreneurial activity to social prosperity and the need for further research on the issue. The performance of small enterprises is positively associated with improving living conditions and has the potential to uplift the standards of individuals experiencing poverty. To the extent that higher productivity offers new job opportunities, their ability to create jobs and generate income contributes to reducing the unemployment rate and allows individuals to engage in activities for improving their living standards. Furthermore, small-scale entrepreneurship should be approached as a tool for improving economic empowerment, self-reliance, and social status, having positive spillover effects on the well-being of local communities. Enabling the environment for SMEs to thrive may have a positive effect on reducing poverty and inequality, assuming that the gap between high and low paying activities is reduced at the expense of the former.

By the same token, Figure 4.1.5 demonstrates the relation between labour productivity (gross value added over the number of employees) and household income (in PPS) for all regions (NUTS2) of the EU27 (see the Methodological Note). Between 2017 and 2021, poverty rates in different regions of Greece showed significant fluctuations and notable deviations from the national average. Regions such as Dytiki Ellada (26.1%), Anatoliki Makedonia and Thraki (25.5%), and Dytiki Makedonia (23.7%) consistently exhibit poverty rates higher than the national average. Improved productivity affords higher earnings, and this may eventually lead to investments for creating new jobs. Regional productivity improvements may have positive spillovers if they increase demand for local goods, multiplying the effects of higher productivity.

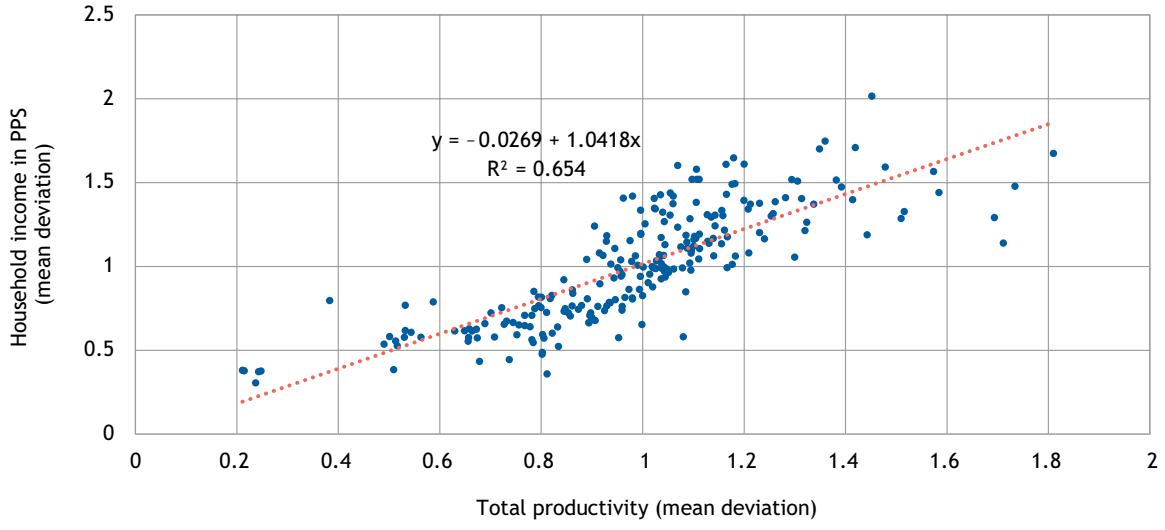
To a certain extent, the level of income is related with productivity and the latter plays a crucial role in supporting per capita household income. However, productivity alone does not guarantee equitable distribution, but it is a necessary prerequisite for future sustainable development.

Figure 4.1.4 Correlation between very small productivity and the poverty threshold (EU27) in PPS, 2017-2021 average



Source: Eurostat and author's calculations.

Figure 4.1.5 Correlation between labour productivity and household income (EU regions) in PPS, 2017-2021 average



Source: Eurostat and author's calculations.

Box 4.1.1 Methodological note

According to the European Price Statistics (Eurostat, 2008, chapter 5), Purchase Power Parities (PPPs) determine the exchange rate equating the purchasing powers of two different currencies. PPPs are indicators used to eliminate price level differences between countries by comparing the quantities of currency units required for purchasing a basket of common goods and services. The measurement unit of these PPP indicators are called Purchase Power Standard (PPS), which is a hypothetical currency used as a common unit of account for all EU27 countries, based on the cost of living. Due to different price levels, the euro currency does not correspond to the same amount of goods in all EU27 and the PPS allows for more accurate and meaningful economic comparisons across countries. In Figures 4.1.1, 4.1.3 and 4.1.4, all measures appear in PPS.

4.2. Banks, financial stability and the finance-growth/ productivity nexus

The relationship between the financial system (and especially banks), productivity and economic growth is old and important in every economy. A review of the relevant literature (Vazakidis and Adamopoulos, 2009; Dritsaki and Dritsaki-Bargiota, 2005; Bai, Carvalho, and Phillips, 2017; Cavalcanti and Vaz, 2017; Liu et al., 2022; Franklin, Rostom, and Thwaites, 2020; Aghion et al., 2019; Manaresi and Pierri, 2019; Azevedo, Mateus, and Pina, 2018; Hassan, di Mauro, and Ottaviano, 2017; Dörr, Raissi, and Weber, 2017; Gatti and Love, 2008; Impullitti, 2022; Heil, 2019; Hondroyiannis, Lolos, and Papapetrou, 2005) indicates that a positive relationship between efficient financial institutions, with an emphasis on banking institutions and credit, on the one hand, and rising TFP and economic growth, on the other hand, has been established in most cases for major economies. Hence, it is important to take into account the financial conditions in an economy along with the financial soundness of its banks when studying the determinants of its productivity and growth.

Moreover the financial health of banks is important for maintaining a constant flow of credit into the economy. Non-performing loans (NPLs) and their effect on banks' balance sheets is a case in point that sounds familiar to the Greek businessmen and policy makers. The relevant literature (Anastasiou, Louri, and Tsionas, 2019; Alexakis and Kalfaoglou, 2019; Nikolopoulos and Tsalas, 2017; Balgova, Nies, and Plekhanov, 2016; Kalfaoglou, 2015; Monokroussos et al., 2017; Karamouzis, 2017; Klein, 2013) establishes a vicious cycle in times of crises and economic distress that runs from rising NPLs to the deteriorating financial health of banks, which results in falling credit supply in the economy. The latter, through the finance-growth nexus explained above, might adversely affect TFP and economic growth.

To the extent that the Greek economy, and within it the Greek banking system, has indeed found itself in such dire conditions, it is interesting to present the evolution of key indicators of financial health in the Greek banking sector from the beginning of a series of crises in the second half of

2008 until the end of 2022. We will also compare the financial ratios under consideration with their counterparts in the Eurozone in order to have an idea of how the Greek case differs from the European average.

At the beginning of the Global Financial Crisis in 2008-2009, the Greek banking sector seemed to be in quite good shape, having collected deposits that were equal to 100% of the GDP, Net Interest Income (NII) of about 3% of total assets, a capital adequacy ratio close to 12%, while securitisations and credit derivatives were less significant than their European counterparts. However, Greek banks were hit by the Greek sovereign debt crisis, which affected both their assets and the collaterals they pledged to the ECB to secure financing. Eventually, Greek debt restructuring through PSI[34] and PSI+ resulted in large bank losses and attempts at recapitalisation in 2011-2012. In conditions of enduring recession, political uncertainty and strategic default, NPLs rose along with deposit withdrawals, which lead to both capital controls and a new round of recapitalisation in 2015 (Louri and Migiakis, 2019). Reaching a level as high as 49.1%, NPLs started to decline from 2017Q3 onwards due to individual banks efforts and government initiatives such as the "Hercules Asset Protection Scheme" I and II, while the Bank of Greece put forward its own proposal for a national bad bank (Loizos, 2022; Mourmouras, 2020; Stournaras, 2019).

To make sense of these developments, this section describes the evolution of credit expansion and the key indicators of Greek banks' financial health within a three-period macroeconomic framework, as this is described by the TFP index being a proxy of the aggregate productivity index of the Greek economy. In Figure 4.2.1a and 4.2.1b, we diagrammatically present the Real GDP index and the percentage change of the TFP index for Greece from almost the beginning of the Global Financial Crisis (2008/9) until the end of 2022.

According to the empirical findings, we can separate the TFP index into three (3) different periods: the first one starts from 2008 and goes until 2013, the second between 2014 and 2020 and the third between 2021 and 2022. The first period portrays the Greek economic crisis that gradually erupted from 2008/9 up to 2013, which is the last year of the continuous recession, as is apparent from Figure 4.2.1a. This downturn is the basic reason why we have this negative mean value regarding the growth of the TFP index (-4.2%). In the second period (2014-20), we have a rather unstable or volatile economic condition which is characterised by alternating indicators of either economic growth or recession. This period includes the effect of the COVID-19 pandemic, which was mainly felt by economic agents in 2020. Because of the above, the percentage change in the TFP index of this period is slightly higher than zero (0.3%). Finally, we have the third period, which starts from 2021 and moves forward up to 2022. This is a period of economic recovery with a positive mean growth of 2.2%.[35] Eventually, given the above empirical findings on TFP, we can discern three periods of Greek economic growth: recession (2008-2013), fluctuation (2014-2020) and recovery (2021-2022) (see Table 4.2.1).

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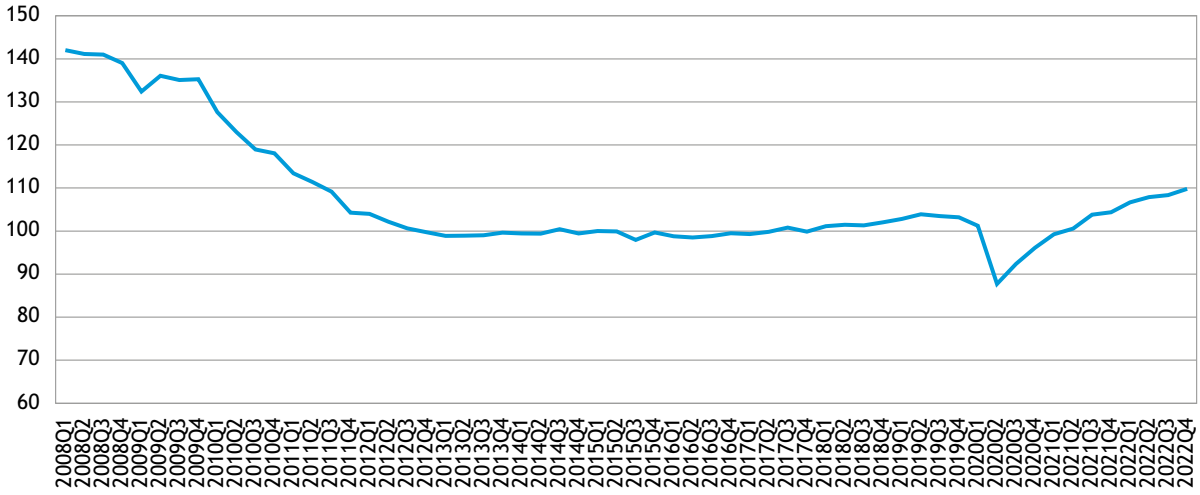
34. Private sector involvement (PSI) was an effort to address the public debt problem in Greece through the restructuring of Greek sovereign bonds in the hands of private investors (Gong, 2020).

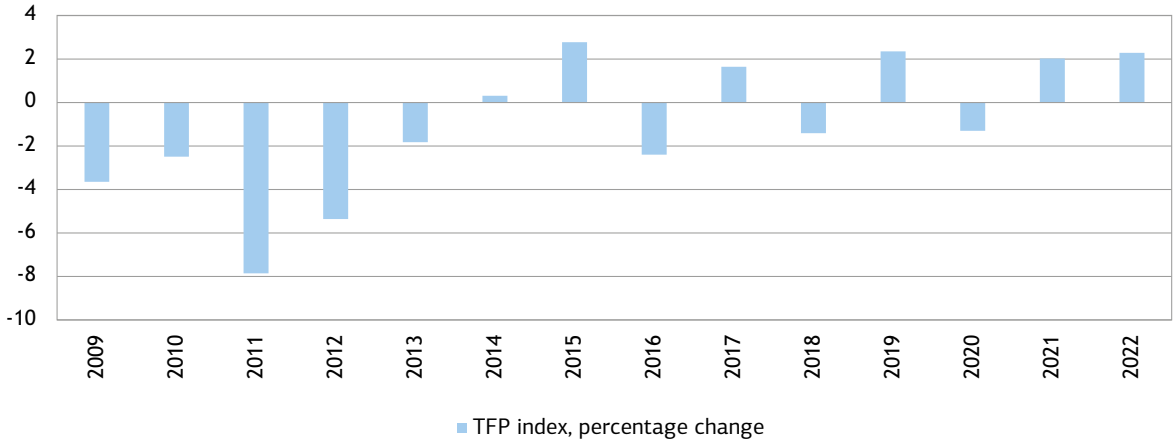
35. Projections for 2023 and 2024 in AMECO data (not shown here) indicate a rising TFP index with an average growth rate of 1.3% for these two years. This is an important reason for considering 2021 as the beginning of a new economic period.

Figure 4.2.1a Real GDP index for Greece, 2015 = 100



Source: Federal Reserve Economic Data, Federal Reserve Bank of St. Louis (data processing by the authors).

Figure 4.2.1b TFP index (2015=100), percentage change



Source: AMECO and own processing by the authors.

Table 4.2.1 TFP index (2015 = 100), percentage change

	Period of TFP characterisation	Mean	Standard deviation	Min	Max
2008 – 2013	Recession	-4.2	2.43	-7.9	-1.8
2014 – 2020	Fluctuation	0.3	2.04	-2.4	2.8
2021 – 2022	Recovery	2.2	0.18	2.0	2.3

Source: AMECO (data processing by the authors).

Taking this categorisation into consideration, we now turn to examine credit growth both in total and in three (3) different categories of credit expansion: consumer, the residential, and business.

Table 4.2.2 indicates an average total credit growth in the recession period which is slightly positive (0.19) despite declining real GDP and an average negative TFP index for the same period (-4.2). To some degree, this disharmony could be attributed to banks' eagerness to maintain their long-term banking relationships with their clients during a recession, as depicted by the corresponding positive average figures for credit expansion concerning business and residential loans (0.31 and 0.44, respectively). This, however, is not the case for consumer loans of this period which exhibit a negative growth (-0.89).

In the second period (2014-2020), which is a period with a small GDP growth volatility (minimal positive and a negative growth values), we observe both a slightly positive TFP index growth (0.3%) and negative aggregate loans growth (-1.35). Furthermore, it is also noticeable that consumer loans present the highest negative value of credit growth (-2.44) while business and residential loans follow with smaller negative values (-1.09 and -1.46 respectively).

Finally, in the third period (2021-2022), total credit growth appears to maintain a negative value (-0.36), which is basically derived from the consumer and residential loans (-5.60% and -4.30%, respectively), while business loan growth is positive and equal to 1.59%. The high positive average value for the TFP index percentage change (2.2%) and the ascending real GDP up to 2022 (just after the effect of the COVID-19 pandemic) indicate the relative inability or hesitation of banks to promptly satisfy the growing demands of the real economy for financing, even as productivity and real GDP grows.

Overall and regardless of the causality direction between credit growth and the TFP index (which is linked with the GDP growth), we should point out that the prolonged period of economic recession initially created a strong slowdown of credit growth and then an accelerated negative growth until mid-2021. Such credit growth development gradually created serious problems regarding the amount of NPLs of the banking system (see Figure 4.2.2).

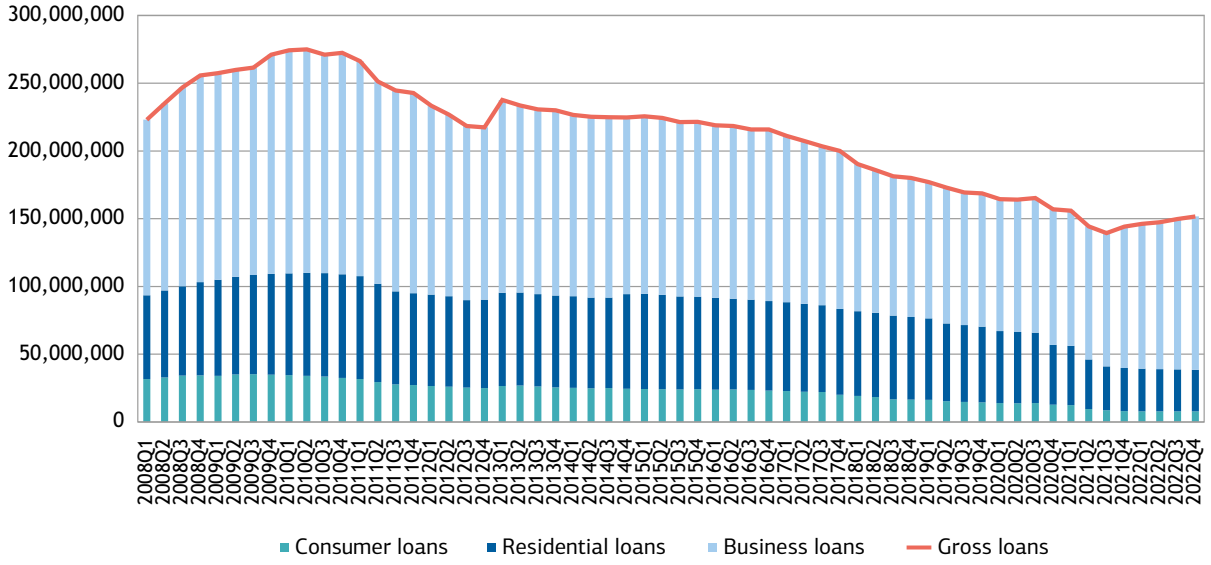
In Table 4.2.3, we present the way NPLs evolved in the three (3) different periods under consideration. In the first period (2008-2013), we observe that, as expected, the consumer category has the highest average NPL ratio (29.6%), followed by the residential and business NPL ratios (16.8% in

Table 4.2.2 Bank credit growth (%) by category, average values

Time periods	2008Q1-2013Q4	2014Q1-2020Q4	2021Q1-2022Q4
Consumer loans	-0.89	-2.44	-5.60
Residential loans	0.44	-1.46	-4.30
Business loans	0.31	-1.09	1.59
Total loans	0.19	-1.35	-0.36

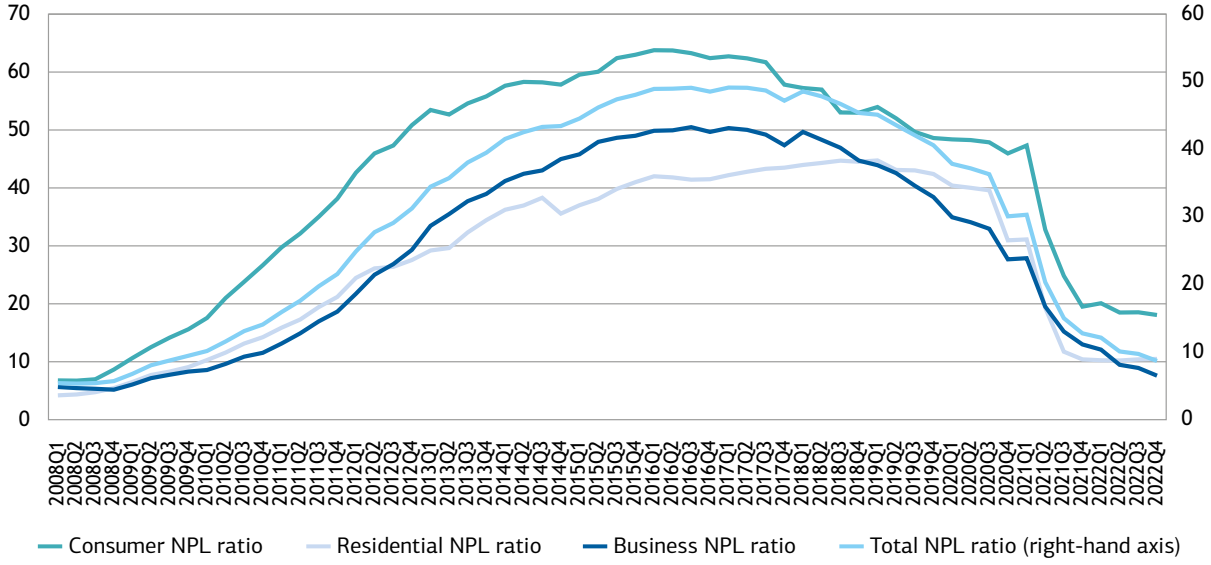
Source: Bank of Greece (data processing by the authors).

Figure 4.2.2 Loans (euro) by category



Source: Bank of Greece (data processing by the authors).

Figure 4.2.3 The NPL ratios



Source: Bank of Greece (data processing by the authors).

Table 4.2.3 NPL ratios by category for Greece, average values

Time periods	2008Q1-2013Q4	2014Q1-2020Q4	2021Q1-2022Q4
Consumer NPL ratio	29.6	56.8	25.0
Residential NPL ratio	16.8	40.8	14.3
Business NPL ratio	16.8	44.4	14.2
Total NPL ratio	18.3	44.6	14.9

Source: Bank of Greece (data processing by the authors).

both cases). Then, at the second period (2014-2020), average NPL ratios obtain their highest values for all categories of loans. Specifically, more than half of the consumers loan portfolios were registered as problematic (56.8%) as well as almost half of the business (44.4%) and a big part of the residential loan portfolios (40.8%). The total NPL ratio of this period was 44.6% on average, while the NPL ratio reached its peak at 49.1% in 2017Q3. In the last period (2020-2022), we observe an impressive reduction of the NPL ratios for all categories of loans. More specifically, the consumer NPL ratio was reduced to 25.0%, while even lower values were recorded for both the business NPL ratio (14.2%) and the residential NPL ratio (14.3%). As a result, the total NPL ratio declined to 14.9% on average and less than 10% during the last two quarters of 2022.

These extremely high figures of NPLs during the greater part of the period under examination, combined with our previous illustration for declining credit supply, confirm a situation where the Greek banking institutions were unable to cater for the financing needs of the real economy due to the deteriorating quality of their assets. This establishes a vicious cycle between financial crises and economic distress that runs from rising NPLs to the deteriorating financial health of banks and results in a falling or dried-up credit supply in the economy. The latter, through the finance-economic growth nexus explained above, might adversely affect the TFP index and economic growth in the future, if measures are not taken to restore the role of the banking system as a sustained source of credit.

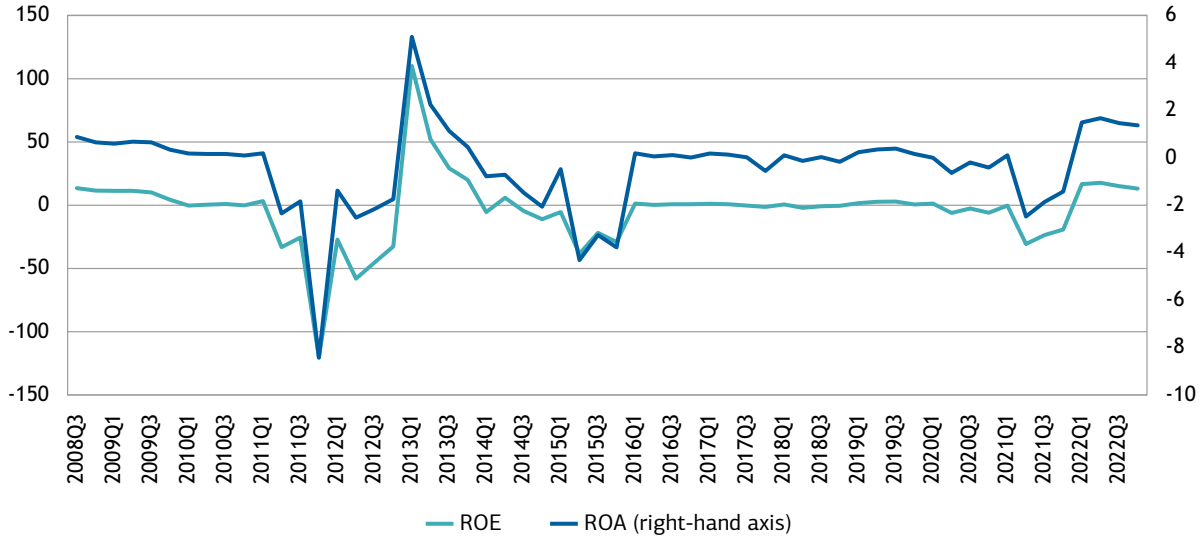
More analytically, the accelerated increase of all categories of NPLs adversely affected banks' profits and liquidity and, hence, financial stability and economic growth through several financial channels. The higher NPLs created a strong rise in banks' provisions and very high operating costs to handle the problematic loans. Additionally, the inevitable need for loss absorption created a higher level of expensive capital which led to a rising weighted average cost of capital (WACC) and, therefore, falling profitability for banks (Anastasiou, Louri, and Tsionas, 2019; Alexakis and Kalfaoglou, 2019; Nikolopoulos and Tsalas, 2017; Balgova, Nies, and Plekhanov, 2016; Kalfaoglou, 2015). To portray these developments in the financial condition of Greek banks, we present in Table 4.2.4 and Figure 4.2.4 the evolution of two profitability ratios –Return on Assets (ROA) and Return on Equity (ROE)– during the period under consideration.

Table 4.2.4 The profitability ratios (ROE, ROA) of Greek banks

		Mean	Standard deviation	Min	Max
2008Q3 - 2013Q4	ROA	-0.31	2.48	-8.43	5.10
	ROE	-2.86	43.64	-120.05	110.09
2014Q1 - 2020Q4	ROA	-0.61	1.25	-4.31	0.38
	ROE	-4.07	9.95	-38.39	5.84
2021Q1 - 2022Q4	ROA	0.04	1.72	-2.47	1.67
	ROE	-1.36	20.09	-30.55	17.78

Source: IMF, Core FSIs, Greece (data processing by the authors).

Figure 4.2.4 The profitability ratios (ROE, ROA)



Source: IMF, Core FSIs, Greece (data processing by the authors).

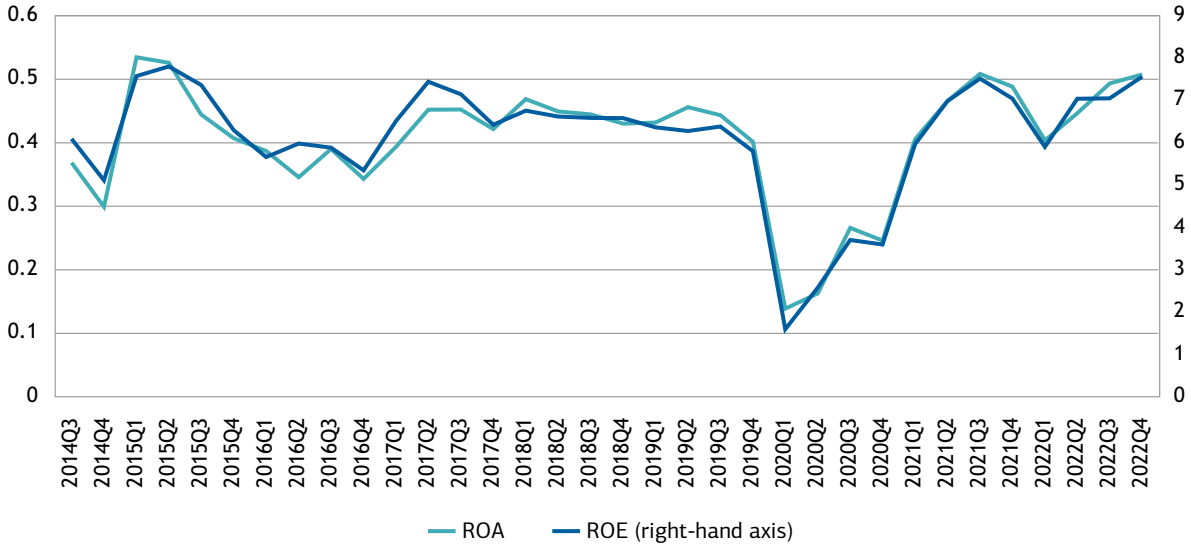
The average figures for ROE and ROA (Table 4.2.4) are negative in all cases except for ROA during the third period (2021-2022), which is close to zero. Additionally, in Table 4.2.5 and Figure 4.2.5, we present the corresponding EU profitability ratios (ROA and ROE). Although the presented period is of a smaller range (2014 to 2022), the positive values of both EU average profitability ratios in all cases, compared to the grim situation described above, leaves us no doubt concerning the intertemporal problematic financial condition of the Greek banking system. Moreover, standard deviations for the respective profitability ratios are far larger in the Greek case than for EU banks, showing the higher risk assumed by stakeholders in the Greek banks as opposed to the median case for EU banks.

Table 4.2.5 The profitability ratios, EU (medians)

		Mean	Standard deviation	Min	Max
2014Q3 - 2020Q4	ROA	0.39	0.10	0.14	0.53
	ROE	5.90	1.51	1.60	7.80
2021Q1 - 2022Q4	ROA	0.46	0.04	0.40	0.51
	ROE	6.88	0.63	5.91	7.56

Source: European Central Bank, ESRB Risk Dashboard, March 16, 2023 (data processing by the authors).

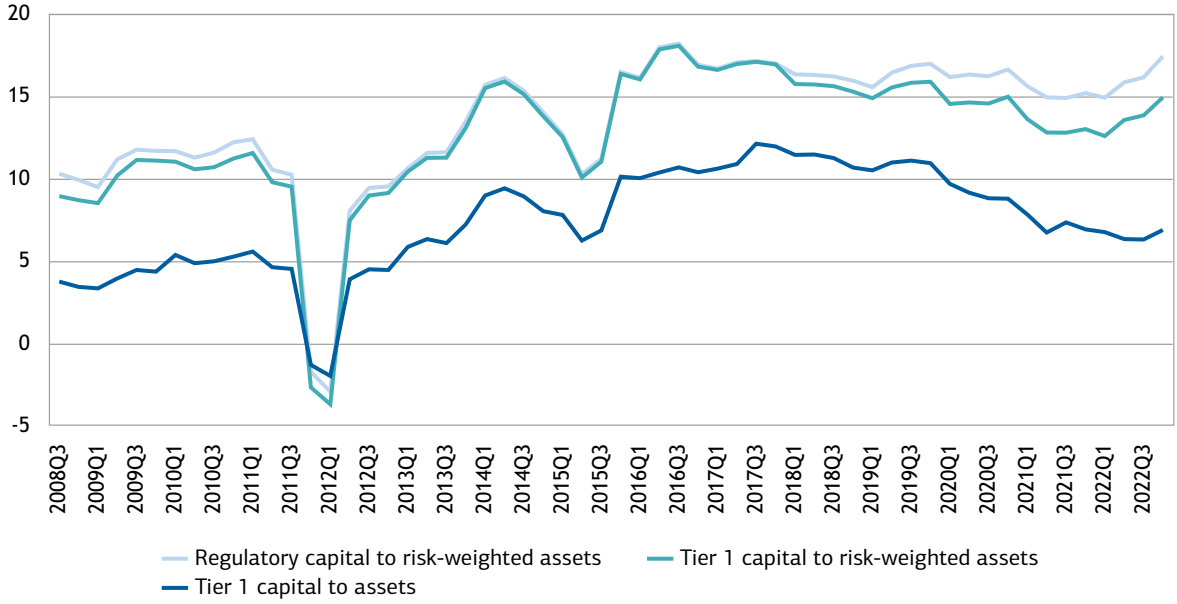
Figure 4.2.5 The profitability ratios (ROE, ROA)-EU (median)*



*The deep U-turn in 2020Q1 is related to the COVID-19 effect.
Source: European Central Bank, ESRB Risk Dashboard, March 16, 2023 (data processing by the authors).

The discrepancy between the Greek and the median EU case in banking is also reflected on the average values for the Capital Adequacy Ratios. As far as the Greek case is concerned, as we can see from Figure 4.2.6 and Table 4.2.6, in the first period, we observe a major trough concerning all the presented capital ratios (Regulatory capital to RWA, Tier 1 capital to RWA and Tier 1 capital to Assets) at the end of 2011 and the beginning of 2012. It was mainly the PSI+ effect and the growing NPLs which led to the recapitalisation of the banking system in 2012 as an attempt to restore its international credibility. The second supplementary recapitalisation of 2015 was a major step towards this end (see the ratios of the second and the third period). After this second recapitalization, the capital Tier1 ratio came closer to the EU median one (see Tables 4.2.6 and 4.2.7), although Tier 1 ratios appear to be lower in the third period.

Figure 4.2.6 Capital adequacy ratios for Greek banks



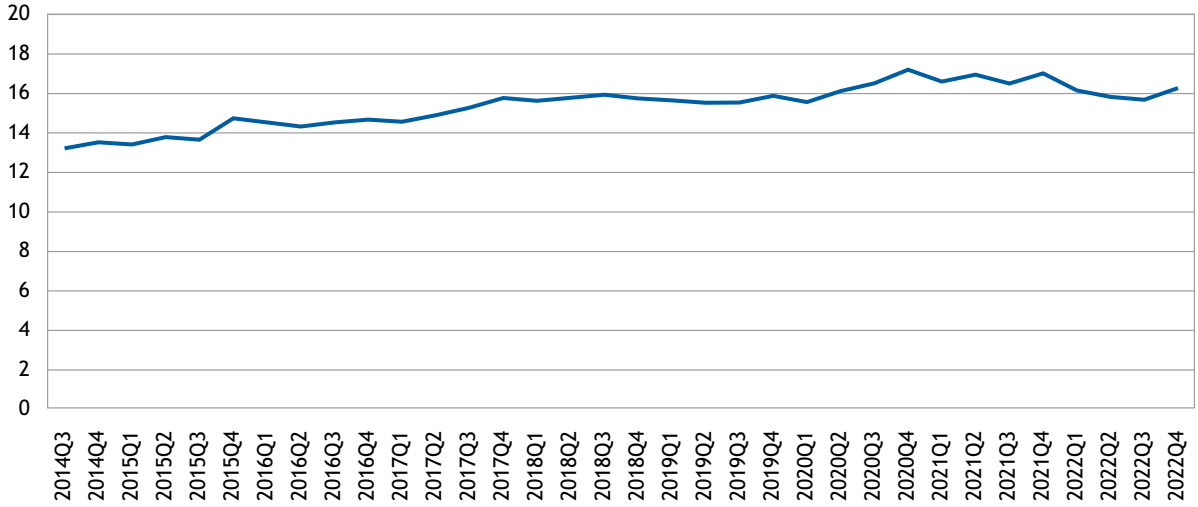
Source: IMF, Core FSIs, Greece (data processing by the authors).

Table 4.2.6 Capital adequacy ratios for Greek banks

Time period	Capital ratios	Mean	Min	Max
2008Q3 - 2013Q4	Regulatory capital to RWA	9.76	-2.89	13.51
	Tier 1 capital to RWA (CET1)	9.05	-3.64	13.12
	Tier 1 capital to Assets	4.30	-1.93	7.27
2014Q1 - 2020Q4	Regulatory capital to RWA	15.93	10.32	18.23
	Tier 1 capital to RWA (CET1)	15.39	10.11	18.10
	Tier 1 capital to Assets	9.98	6.29	12.17
2021Q1 - 2022Q4	Regulatory capital to RWA	15.66	14.94	17.46
	Tier 1 capital to RWA (CET1)	13.44	12.62	14.98
	Tier 1 capital to Assets	6.93	6.35	7.87

Source: IMF, Core FSIs, Greece (data processing by the authors).

Figure 4.2.7 The Common Equity Tier 1 (CET1) ratio* (EU median)



*CET1 = Tier 1 capital to RWA.

Source: European Central Bank, ESRB Risk Dashboard, March 16, 2023 (data processing by the authors).

Table 4.2.7 CET1 ratio, EU (medians)

	Mean	Min	Max
2014Q3 - 2020Q4	15.08	13.22	17.21
2021Q1 - 2022Q4	16.38	15.69	17.02

Source: European Central Bank, ESRB Risk Dashboard, March 16, 2023 (data processing by the authors).

5. Conclusions and Policy Suggestions

The findings of this annual report stress that the Greek economy has returned to normality as it has fully reversed the impact of the COVID-19 pandemic and has improved its position in several competitiveness indicators. During 2022, labour productivity per hour worked increased by 0.3%, and labour productivity per person employed increased by 2.0%, whereas TFP increased by 2.9% (using hours worked) and by 3.8% (using employment). Nevertheless, the gaps between the labour productivity of the Greek economy and the average labour productivity in the EA19 and the EU27 are considerable and persistent, with no signs of convergence.

The economic sectors having significant labour productivity increases in 2022 include "Construction" (16.2%), "Arts and entertainment" (10.4%), "Professional, scientific and technical activities" (6.3%) and "Wholesale and retail trade" (5.1%). Also, capital productivity increased by 5.8% in 2022, and the capital stock increased after twelve consecutive years of decline. Public finance improved drastically, due to the rapid decline in general government expenditure from 59.7% of GDP in 2020 to 50.3% in 2023 and the stabilisation in public revenues, while public debt declined from 212% of GDP in 2020 to 166% in 2023. The CPI-based REER slightly decreased in 2022 for the fourth consecutive year, and the ULCT-based REER also decreased in 2022 for the second consecutive year, reaching its lowest point during 2010-2022, showing Greece's improved trade competitiveness. The ULC also decreased in 2022 for the second consecutive year, while it increased in the EA19 and the EU27. The relative ULC decreased by 1.7 p.p. in 2022, compared to 2021, verifying the amelioration of Greece's competitive position (relative to the EA).

Despite the positive growth prospects, the GDP growth in 2022 was mainly driven by private consumption and to a lesser extent by investment. Additionally, the deterioration in current accounts (deficit of 9.7% over GDP in 2022) contributed to -6.2% of GDP growth, as imports significantly outperformed exports. The intense core-periphery disparities also remain, as the region of Attiki continues to perform significantly better than the other regions of the country in all sub-indices and in almost all pillars of the RCI, and it is the only transition region in Greece, while all the other regions are less developed regions. At the same time, the continuation of the war in Ukraine, the surge in energy prices, persistent inflation, the increased cost of borrowing for businesses and households, adverse demographic changes, technological backwardness and the more frequent natural disasters due to climate change pose additional challenges to the Greek economy. Based on the findings of the analyses carried out in the present report, the following sections encompass a set of conclusions and policy proposals for supporting the productivity and competitiveness of the Greek economy.

Boosting investment for sustainable and resilient growth

The implementation of the Greek RRP is expected to yield a substantial economic boon for the country, with the budget forecasted to induce a surge in economic output by an estimated amount

of 13.7 billion euro. This is significant, especially in light of the adverse impacts the COVID-19 pandemic had on economies worldwide. Moreover, the corresponding spike in employment opportunities, amounting to a potential addition of approximately 400,000 jobs, will be a critical factor in revitalising the Greek economy. The projected numbers, when measured against Greece's 2020 GDP and employment metrics, indicate a significant growth, i.e., 8.3% in output and 10.5% in employment. However, when juxtaposed with Greece's economic apex in 2008, the current path to recovery, while notable, seems somewhat lackluster. Construction and Manmonths stand out as pivotal sectors within the RRP's expenditure categories. These two sectors alone are expected to propel cumulative output by about 5.0% and fuel employment growth by roughly 7.1%. Their predominant role suggests that specific sectors can have outsized impacts on national economic resurgence.

The analysis suggests that the RRP may not be entirely aligned with Greece's long-term strategic objectives. There appears to be an insufficient emphasis on sectors that are characterised by high productivity, reduced dependence on imports, and minimal CO2 emissions. The concentration of 60% of output multiplier effects in specific areas, such as "Modernise and improve resilience of key economic sectors", suggests potential overreliance on a limited set of sectors and may not holistically cater to the broader goals of sustainable productivity and resilience. The anticipated increase in CO2 emissions, estimated at about 3,776 KT, underlines the environmental cost associated with the economic boost. As global awareness about climate change and sustainability grows, the spike in environmental emissions could pose challenges for Greece in terms of its commitments to international climate agreements and its reputation on the global stage.

As Greece progresses with its recovery plans and seeks approval from institutions, like the Economic and Financial Affairs Council (ECOFIN), it might benefit from:

- Revisiting the RRP to ensure a more balanced emphasis across sectors, particularly those that bolster productivity without compromising on environmental goals.
- Implementing rigorous environmental measures to mitigate the projected rise in CO2 emissions.
- Expanding strategic partnerships and exploring alternative financing avenues to reinforce its economic revitalisation trajectory.

To sum up, while the RRP provides a promising pathway for Greece's economic resurgence post the COVID-19 setbacks, there is room for strategic refinements to ensure a holistic, sustainable, and robust recovery.

Enhancing macroeconomic stability and competitiveness

Greece appears to be on a steady path to recovery. Nevertheless, investments and reforms aiming to improve productivity, competitiveness and resilience are vital, as the consecutive deficits in goods are a festering sore for the Greek economy. Relevant actions and reforms to be implemented by policy makers should help the country to: (i) become less dependent on imports

of goods, (ii) enhance its exports and domestic production of goods without sacrificing surpluses in services, (iii) reconsider the mixture of its economy towards a more balanced scheme between goods and services, (iv) become as self-sufficient as possible in terms of goods, and (v) become more extroverted in the trade balance and improve the current account.

To this purpose, several incentives could be given to strengthen the primary and secondary sectors, especially through the increased disbursement of grants (€17.8 billion) and loans (€12.7 billion) from the RRF, also taking into advantage of the bestowed investment-grade rating and the expected lower interest rates when issuing bonds. Also, emphasis could be put on the bank financing of SMEs –the backbone of the Greek economy– which employ 85% of total employees and generate 66% of total value added, on average. The regaining of the investment grade for Greece by the world's fourth largest credit ratings agency, DBRS, on 8 September 2023, is indeed a good omen for the Greek economy. This is particularly important for banks and non-financial corporations (NFCs), and –to a lesser extent– for the Greek debt, mainly because of its composition. According to the Greek Public Debt Management Agency, bonds constitute about 21% of the central government debt, which amounts to more than €400 billion in 2022. As a result, only about €47 billion of debt (given that the ECB's Greek bond holdings are close to €38 billion) could be positively affected though reissuance at a lower interest rate.

Regarding the potential benefits on NFCs due to Greece's rating upgrade to investment grade, NFCs could enjoy lower interest rates and cost of debt (COD) when issuing corporate bonds. The improved sovereign credit rating also implies a smaller country risk equity premium (CREP). As a result, a smaller CREP –with all other things remaining constant– leads to a reduced cost of equity (COE), which combined with a lower COD, leads to a reduced weighted average cost of capital (WACC) as well. Therefore, theoretically speaking, lower values for COD, COE and WACC –keeping all other things constant– imply that discounted expected future cash flows will be increased due to smaller discount rates, leading to higher fundamental firm valuations (see e.g., Damodaran, 2012). Such valuations appear to have been achieved so far by investors who have incorporated the recovery of Greece's investment grade rating much earlier than its official bestowment by DBRS on 8 September 2023. Particularly, the Greek stock market enjoyed up to +53.64% (+53.14%) in the first 8 months of 2023 compared to the average (median) daily price of the index in 2022.[36] Consequently, it remains to be seen whether the Greek stock market resumes the bullish trend or returns to bearish movements.

Finally, the upgrade of Greece's sovereign credit rating from the speculative grade to the investment grade could benefit the Greek banks with (a) better terms when issuing bonds for the Minimum Requirement for own funds and Eligible Liabilities (MREL), (b) lower interest rates when participating in the interbank market and when receiving loans from the ECB, and (c) lower risk-weighted assets (RWAs),[37] Given such benefits leading to lower expenses, increased profitability, and greater capital buffers, it will be a unique opportunity for the Greek banks (a) to

36. Also, the average (median) daily price of the stock index in the first 8 months of 2023 denotes a +32.1% (+27.7%) return relative to the average (median) daily price of the stock index in 2022.

37. According to the BIS standardised approach, exposures to sovereigns with BBB+ to BBB- ratings calls for 50% risk weight, while exposures to sovereigns with BB+ to BB- ratings require a risk weight of 100%.

increase their loans and finance the real economy, (b) to replace internally the huge amount of deferred tax credits (DTCs) with high-quality capital and accelerate DTC amortization,[38] as well as (c) to reduce the unprecedented skyrocketing interest rate spread between loans and deposits (Bertsatos, 2023), especially if we consider the €46 billion capital granted to banks since 2011 by the Hellenic Financial Stability Fund (HFSF), and the imminent losses –amounting to more than €40 billion at current prices– from its disinvestment plans.

Fostering digitisation and the use of disruptive technologies

Greek universities have a relatively good record (and rank among the EU27) regarding scientific publications and, particularly, AI publications. What is missing is the sufficient connection and cooperation between universities and companies. Moreover, the primary and secondary education system needs significant reforms. Greek school kids do not perform well on PISA tests, with scores in continuous decline, and the number of pupils per teacher is too big. Employee training is another important issue that both companies and the state have to work on together. Emphasis is needed in digital technological skills, the attraction of foreign highly skilled personnel and the reversal of the brain drain. Another major reform that the Greek economy needs is that of justice. Greek justice takes by far the longest time to settle a case, and the enforcement of contracts is ineffective. Scientific research legislation has to improve to encourage innovation, and the legal environment needs reform to better support development and application technology.

Regarding Greek companies, they need to better respond to opportunities and threats, be more agile, improve their ability to use big data and analytics to support decision making and adequately address cyber security issues. Finally, as mentioned above, Greek universities have a good record of AI publications. What needs to be done is to accelerate the knowledge transfer, cooperation and partnerships between business and universities. AI publications need to be transformed into high impact AI projects, AI software and applications development through a venture capital funding scheme that now is missing, and Greece ranks very low in VC investments in AI.

ICT and, especially, the emerging Industry 4.0 technologies are associated with increased productivity, competitiveness and resilience. Greek firms lag significantly behind their European counterparts in the use of CRM software solutions, CC services, 3D printing, automation robots and AI. Therefore, the need for Greek firms to accelerate their efforts towards digital transformation with a special focus on Industry 4.0 technologies is of the utmost importance. Another important issue of concern that emerged from the preceding analysis relates to the small number of Greek firms that take into consideration the environmental footprint of ICT. Hence, awareness about environmental sustainability issues associated with ICT, as well as the circular economy, should be further enhanced and reinforced.

38. According to the May 2023 Financial Stability Report of Bank of Greece, DTCs in the Greek banking system amount to €13.7 billion, representing 52% of total regulatory capital.

From a policy perspective, the acknowledgement of the need to further support the implementation of Industry 4.0 and accelerate the digital transformation of the Greek firms has led to a series of reform interventions. A representative and highly relevant example of such an initiative is the "Smart Manufacturing" project, part of the National Recovery and Resilience Plan (Greece 2.0) and the National Strategy for Industry, through which the Greek government approved, in 2022, €73 million to fund SMEs in the industrial sector in order to adopt technologies such as AI, big data analysis, smart manufacturing, and autonomous robots. The proper implementation of relevant initiatives, with the highest possible participation of Greek enterprises, may indeed contribute to accelerating their efforts towards digital transformation, so as to take full advantage of the immense opportunities emerging in the context of Industry 4.0.

Strengthening the financial system

The Greek financial system is not an exception to the relationship, explained in the literature, between bank credit and economic productivity and growth. The prolonged economic recession from 2008 to 2013 and the subsequent fluctuations in real GDP were also reflected in the evolution of the TFP index growth, as this is expressed through the segmentation of this index. More specifically, the economy went through a negative TFP percentage change period in 2008-2013 to a volatile productivity growth segment in 2014-2020 and, finally, to a positive one in 2021-2022. Our analysis showed that this TFP evolution can be related to a gradual slowdown of credit growth in the first period followed by negative growth rates in the next two periods. It was also mirrored by the values of the banking system's profitability ratios (ROE and ROA), which were characteristic of banks' adverse financial situation. As a result, we have had an explosion of the NPL ratio, which in 2017 reached 49.1% of total gross loans. However, the first and second (supplementary) recapitalisations of 2012 and 2015 substantially helped the Greek banking system to restore its capital base. However, this positive development for Greek banks, along with the sharp decline of their NPL ratios at the end of the third period, should be reflected in a further rise in extended bank credit, so as to sustain the higher levels of both the TFP and GDP growth, which seem to characterise the period of economic recovery from 2021 and thereafter.

Treating economic disparities

Addressing economic disparities and promoting productivity and inclusive growth in Greece remains a priority. Government actions are faced with the twin challenge of pursuing a wide range of policies that reduce inequalities, while, at the same time, support productivity. In this respect, the production of goods of higher quality and complexity is crucial. Among others, relevant policies for combatting inequalities are:

- Policies that focus on improving access to training for the acquisition of relevant skills to enhance productivity and potentially reduce disparities.

- Labour market reforms ought to be directed towards promoting fair and inclusive employment and enhancing a framework of continuous social dialogue between employers and employees to ensure that workers in the Union earn adequate wages (principle 6 of the European Pillar of Social Rights).
- Robust social protection to provide adequate coverage of the social security and services that are essential for advancing social cohesion, directed to small-scale entrepreneurs.
- As long as the conditions for repayment are met, easing access to affordable finance and supporting small-scale entrepreneurship should be a policy priority. Financial inclusion through particular schemes may enable small firms to invest in new technologies and innovative techniques.
- Specialised initiatives that facilitate technology transfer and collaborations with other firms, even abroad, to enlarge the network and create linkages for export promotion.

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GREEK NATIONAL PRODUCTIVITY BOARD ANNUAL REPORT 2023

The 2023 edition of the Greek National Productivity Board Annual Report is constructed as follows. Section 1 is an introductory section that discusses some major policy challenges and recent developments in productivity indices, highlighting progress and future potentials. Section 2 features our economic projections and a detailed presentation, decomposition and sectoral analysis of the main productivity metrics. It also offers a holistic evaluation of public investments sourced from the Greek Recovery and Resilience Plan, signifying those revisions that could support sustainable and resilient growth. Section 3 shifts the focus on the performance and competitiveness of Greek firms, especially in digitisation and Industry 4.0 technologies, placing special emphasis on the integration of Artificial Intelligence (AI). Section 4 probes the relationship between social (income) inequalities and productivity growth in Greece, highlighting the socio-economic implications. Furthermore, it examines the relationship between bank credit, financial stability, and the interwoven factors of Total Factor Productivity (TFP) and economic growth, seeking to understand the broader financial dynamics at play. Lastly, Section 5 summarises and concludes, offering useful policy suggestions for the implementation of reforms and investment that could enhance a more inclusive, sustainable and resilient growth.

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