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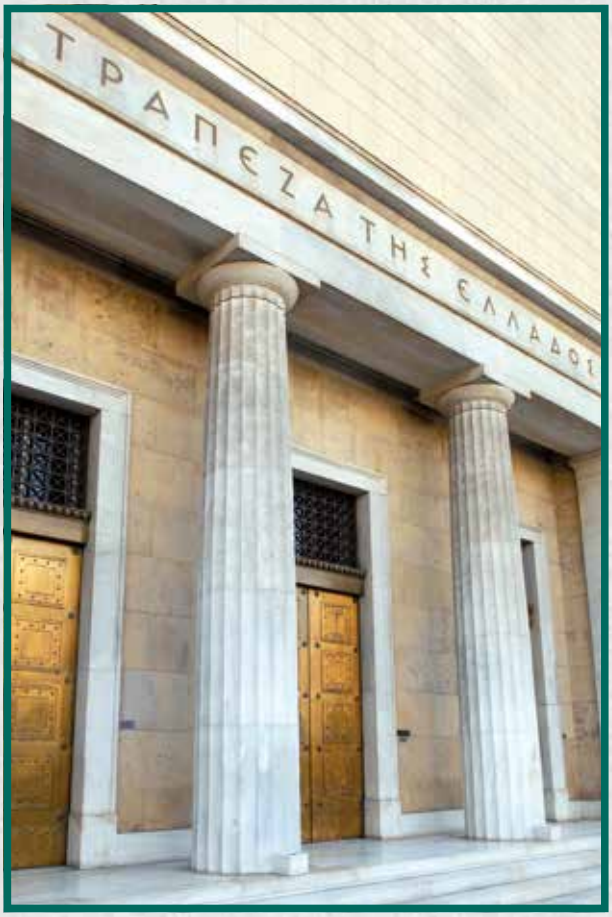

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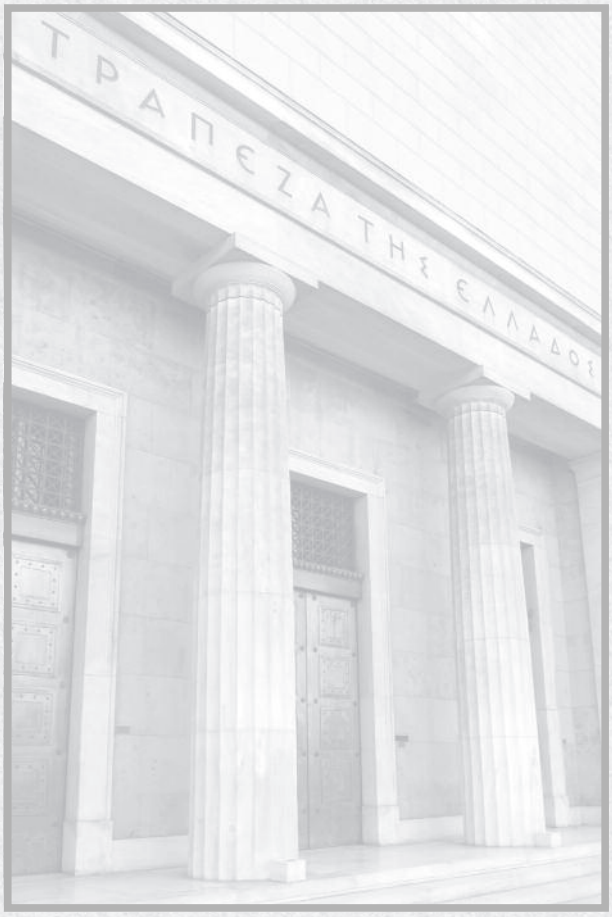

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BANK OF GREECE
21, E. Venizelos Avenue
GR-102 50 Athens

www.bankofgreece.gr

Economic Analysis and Research Department – Secretariat
Tel. +30 210 320 2393

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Sofia Anyfantaki
Bank of Greece, Economic Analysis and Research Department

Yannis Caloghirou
National Technical University of Athens, Laboratory of Industrial and Energy Economics, School of Chemical Engineering

Konstantinos Dellis
University of Piraeus, Department of Economics

Aikaterini Karadimitropoulou
University of Piraeus, Department of Economics

Filippos Petroulakis
Bank of Greece, Economic Analysis and Research Department

ABSTRACT

The Greek economy has so far failed to shift its production structure towards more complex, high value-added activities incorporating knowledge-intensive practices. Greece lacks a systemic "activating knowledge" dimension. Given the country's low performance in innovation and knowledge diffusion relative to EU peers, we focus on two specific problem areas of Greek industry: skills and management practices. Both areas are key requirements to achieve robust productivity growth, in which Greece has been shown to be chronically lagging behind its peers. First, we provide an in-depth look at skills indicators to identify the scope for action, particularly in addressing mismatch. A novel result is that, by utilising mismatch indicators aggregated from microdata sourced from the recent OECD Survey of Adult Skills that was conducted as part of the Programme for the International Assessment of Adult Competencies (PIAAC), we show that Greece has the highest overskilling for professional occupations. We also corroborate previous findings about the negative relationship between skills mismatch and firm productivity. Second, we use firm-level data from the World Management Survey to give a review of management practices in Greek industry and explore the quality of these practices and their association with productivity. Finally, we use information from a novel survey on entrepreneurship, technological developments and regulatory change, and examine the structural characteristics of Greek firms that innovate and tend to adopt new technologies, with a focus on the role of size, ownership structure, global value chain participation and human resource practices. Our empirical findings provide valuable input into concrete policy proposals to increase productivity in Greek manufacturing.

Keywords: skills; management; innovation; technology; knowledge; family firms

JEL classification: D22; J24; J50; L22; O31; O32

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ΔΕΞΙΟΤΗΤΕΣ, ΔΙΟΙΚΗΤΙΚΕΣ ΠΡΑΚΤΙΚΕΣ ΚΑΙ ΥΙΟΘΕΤΗΣΗ ΝΕΩΝ ΤΕΧΝΟΛΟΓΙΩΝ ΣΤΙΣ ΕΛΛΗΝΙΚΕΣ ΜΕΤΑΠΟΙΗΤΙΚΕΣ ΕΠΙΧΕΙΡΗΣΕΙΣ

Σοφία Ανυφαντάκη
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

Γιάννης Καλογήρου
Εθνικό Μετσόβιο Πολυτεχνείο, Εργαστήριο Βιομηχανικής και Ενεργειακής Οικονομίας, Σχολή Χημικών Μηχανικών

Κωνσταντίνος Δελλής
Πανεπιστήμιο Πειραιώς, Τμήμα Οικονομικής Επιστήμης

Αικατερίνη Καραδημητροπούλου
Πανεπιστήμιο Πειραιώς, Τμήμα Οικονομικής Επιστήμης

Φίλιππος Πετρουλάκης
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

ΠΕΡΙΛΗΨΗ

Ο αναγκαίος μετασχηματισμός της δομής της ελληνικής οικονομίας προς ένα βιώσιμο παραγωγικό μοντέλο αγαθών και υπηρεσιών υψηλής προστιθέμενης αξίας και έντασης γνώσης δεν έχει ακόμη ολοκληρωθεί. Η Ελλάδα αργεί να μετασχηματιστεί σε "οικονομία της γνώσης". Δεδομένου ότι κατατάσσεται στις χώρες με μέτριες επιδόσεις στην καινοτομία σε σχέση με τις υπόλοιπες χώρες της ΕΕ, η μελέτη εστιάζει σε δύο τομείς όπου η ελληνική βιομηχανία εξακολουθεί να υστερεί: το σύστημα ανάπτυξης δεξιοτήτων και τις διοικητικές πρακτικές (μάνατζμεντ). Η βελτίωση στους δύο αυτούς τομείς αποτελεί βασική προϋπόθεση για την επίτευξη ισχυρής αύξησης της παραγωγικότητας. Στην παρούσα μελέτη, πρώτον, παρέχουμε μια ενδελεχή επισκόπηση των δεικτών δεξιοτήτων με σκοπό να προσδιορίσουμε τις δυνατότητες σχεδιασμού στοχευμένων μέτρων πολιτικής, ιδιαίτερα για την αντιμετώπιση της αναντιστοιχίας δεξιοτήτων. Ένα αξιοσημείωτο αποτέλεσμα της μελέτης είναι ότι, με βάση μικροδεδομένα από το πρόσφατο Πρόγραμμα για τη Διεθνή Αποτίμηση των Ικανοτήτων των Ενηλίκων (Programme for the International Assessment of Adult Competencies – PIAAC) του ΟΟΣΑ για την επιστημονική καταγραφή και ανάλυση πληροφοριών σχετικά με τις δεξιότητες και ικανότητες του ενήλικου πληθυσμού, η Ελλάδα έχει το υψηλότερο ποσοστό απασχόλησης εργαζομένων με πλεονάζουσες δεξιότητες όσον αφορά τις θέσεις εργασίας που απαιτούν υψηλά προσόντα. Επίσης, επιβεβαιώνουμε προηγούμενα ευρήματα σχετικά με την αρνητική συσχέτιση μεταξύ της αναντιστοιχίας δεξιοτήτων και της παραγωγικότητας της επιχείρησης. Δεύτερον, χρησιμοποιώντας δεδομένα σε επίπεδο επιχείρησης από την Παγκόσμια Έρευνα Μάνατζμεντ (World Management Survey), παρέχουμε μια επισκόπηση των διοικητικών πρακτικών στην ελληνική βιομηχανία και διερευνούμε την ποιότητα αυτών των πρακτικών, καθώς και τη συσχέτισή τους με την παραγωγικότητα. Τέλος, αξιοποιούμε τα αποτελέσματα από μια νέα έρευνα για την επιχειρηματικότητα, τις τεχνολογικές εξελίξεις και τις κανονιστικές αλλαγές με σκοπό να εξετάσουμε τα δομικά χαρακτηριστικά των επιχειρήσεων που καινοτομούν και τείνουν να υιοθετούν τις νέες τεχνολογίες, δίνοντας έμφαση στο ρόλο του μεγέθους της επιχείρησης, της μορφής ιδιοκτησίας της, της συμμετοχής της στις παγκόσμιες αλυσίδες αξίας και των πρακτικών διαχείρισης ανθρώπινων πόρων. Τα εμπειρικά ευρήματα αποτελούν βάση για τη διατύπωση συγκεκριμένων προτάσεων πολιτικής με στόχο την αύξηση της παραγωγικότητας στην ελληνική βιομηχανία.

SKILLS, MANAGEMENT PRACTICES AND TECHNOLOGY ADOPTION IN GREEK MANUFACTURING FIRMS[1]

Sofia Anyfantaki
Bank of Greece, Economic Analysis and Research Department

Yannis Caloghirou
National Technical University of Athens, Laboratory of Industrial and Energy Economics, School of Chemical Engineering

Konstantinos Dellis
University of Piraeus, Department of Economics

Aikaterini Karadimitropoulou
University of Piraeus, Department of Economics

Filippos Petroulakis
Bank of Greece, Economic Analysis and Research Department

1 INTRODUCTION

Significant progress has been achieved since the Greek economy suffered one of the deepest and longest recessions of any advanced economy to date. The large twin deficits had been reduced and the Greek economy had gradually recovered until the onset of the COVID-19 pandemic. Despite the international shock halting the upward growth trajectory and new geopolitical risks raising uncertainty, the Greek economy has showed resilience. Today, however, the Greek economy continues to face a number of challenges, which constrain its long-term prospects. Greece remains a laggard among peer countries in various domains that are critical for sustainable long-term growth: the production structure remains largely unchanged and domestic output still lacks sufficient knowledge-intensive characteristics. The pivotal role of innovation and technological change for economic growth has been studied and stressed repeatedly. But although the Greek innovation ecosystem has made progress in recent years, there are still weaknesses that prevent it from becoming the leading factor in the transformation process of the Greek economy. Substantial increase in potential growth is only possible through enhancing capabilities, raising the productivity of existing resources and engaging in innovation.

Against this background, in this study, we focus on selected but important problem areas of Greek industry. We review well-known stylised facts and empirically establish new ones. We use international datasets, allowing us to more clearly pinpoint deficiencies and benchmark Greece against its peers, as well as introduce some novel survey data. Our goal is to gain a more granular view, so as to identify specific problem areas for policymakers and stakeholders to target. In particular, we focus on skills and management practices, while also providing an in-depth examination of Greek firms' innovation activity and technological readiness.

Our focus is dictated by both the importance of each issue and the need for improvement. Innovation, which heavily relies on advanced knowledge, is a key contributing factor to productivity growth, the main source of sustainable long-term growth today. At the same time, in this new technological age, the increasing importance of human capital is underlined, as well as the need to ensure a good match between demand for and supply of skills.

1 This project is part of the Hellenic Observatory Research Calls Programme 2020, funded by the A.C. Laskaridis Charitable Foundation and Dr Vassili G. Apostolopoulos. Warm thanks are extended to Hiona Balfoussia for very useful remarks and comments. The views expressed in this article are of the authors and do not necessarily reflect those of the Bank of Greece. The authors are responsible for any errors or omissions.

Worker skills and managerial practices are widely recognised as key inputs in modern economies and are the intensive focus of research and international organisations. Yet, Greece scores relatively poorly across a wide range of indicators pertaining to these issues. The ability of firms to attract and foster skilled human and managerial capital affects their capacity to innovate in production, technique and organisation, as well as to incorporate new technologies and increase their productivity.

We begin by reviewing evidence on the dimensions of the skills gap in Greece to identify the scope for action, particularly in addressing mismatch. It has been argued that although Greece has experienced one of the largest increases in educational attainment among OECD countries, the transition from university to the labour market is one of the most difficult (OECD 2020a). This phenomenon is likely related to the extensive skills mismatch, with the country typically featuring at the last places among EU Member States in various relevant rankings (e.g. Cedefop's European skills and jobs survey). The financial crisis made things worse, as many highly educated and/or skilled people became unemployed or underemployed, and a large number left the country ("brain drain"). However, the skills mismatch problem in Greece seems to be rooted in deeper structural weaknesses in both the economy and the educational system (Katsikas 2021). Today, skills development is a more complex endeavour than in previous decades, when mass schooling had led to drastic increases in human capital. Persistent skills gaps and mismatches come at economic and social costs, while skills shortages can negatively affect labour productivity and hamper the ability to innovate and adopt technological advances.

High levels of overqualification have different implications for policy action, depending on whether they reflect a dearth of skilled jobs or a misallocation of workers across jobs. To explore the empirical relationship between skills mismatch and firm productivity, we use microdata from the recent OECD Survey of Adult Skills that was conducted as part of the Programme for the International Assessment of Adult Competencies (PIAAC). We focus on whether skills mismatch is different for highly skilled ("professional") jobs and we find that Greece has by far the highest professional overskill mismatch compared with all other countries in the sample. Given this evidence, and in order to examine the relative importance of overskill mismatch in professional occupations, we follow Adalet McGowan and Andrews (2015), who use the Olley-Pakes (1996) method to split aggregate sectoral productivity into a within-firm component and an allocative efficiency component. Overall, our results corroborate previous findings that overskilling has a negative effect on labour productivity.

We next turn to another important area for action, namely management practices as a driver to enhance productivity in the manufacturing sector. The empirical literature on management practices has established their importance in explaining differences in productivity between and within countries and sectors, and a growing body of experimental evidence supports a causal interpretation (Scur et al. (2021) provide an overview). Management practices have been recognised as akin to a technology (Bloom et al. 2016) and as a key input for innovation and technology absorption (Acemoglu et al. 2007). We examine the management practices of Greek industry through both an international comparison and a cross-sectional analysis, using firm-level data from the World Management Survey (WMS).

We find a high dispersion of management practices within the country. This evidence, combined with the established poor quality of management practices in Greece compared with other countries (Genakos 2018), suggests that although there are a few leaders in terms of good management practices, the diffusion is quite low. We further identify specific areas in which managers in Greece tend to lag behind. Greek firms perform worst in issues requiring people management, planning and oversight, as well as synergies, dialogue and

collaboration. They do best in issues requiring decision-making, possibly by a single individual. Moreover, we find that Greece has the largest gap in management practices between domestic firms and foreign multinationals operating in the country. We further point to an interesting result: Greek firms exhibit the lowest levels of employee autonomy. Given the high incidence of family-managed firms, this paints the picture of a corporate culture tied around a founder, with little room for talent development and firm decentralisation. We establish that there is a positive relationship between management quality and firm performance in terms of productivity for Greek manufacturing firms, which is robust across all broad management categories.

In increasingly dynamic and competitive environments, the capacity to acquire, transform and exploit external knowledge is crucial for firms to innovate, renew competitive advantage and sustain performance. Innovation has become a fundamental capability to survive competition, particularly for small and medium-sized enterprises (SMEs). At the same time, the advent of the 4th Industrial Revolution (4IR) emphasises the potential importance of digital adoption for sustained competitiveness. We examine structural characteristics of firms' innovation activity and digital adoption, using information from a novel survey on entrepreneurship, technological developments and regulatory change completed in 2019 by the Laboratory of Industrial and Energy Economics of the National Technical University of Athens (LIEE/NTUA) and supported by the Hellenic Federation of Enterprises (SEV). We focus on the role of firm size, family versus non-family firms, participation in global value chains (GVCs) and talent management to examine differences between (i) innovative versus non-innovative firms and (ii) firms that are in the forefront of digital technologies.

We show that firm size is in fact an important determinant of product innovation. Somewhat surprisingly though, we find that family firms do not exhibit subpar performance with regard to innovation, although they are substantially less likely to have an in-house R&D department (an indicator of persistent innovation activity). Cohen and Levin (1989) outline some arguments for large firms being more innovative: they can use internal funds to finance the risky R&D activities, they have access to additional sources to finance their innovation activities, they may better exploit economies of scale, etc. At the same time, differences between the innovation processes of family versus non-family firms have become an important area of research in the management and economics literature (De Massis et al. 2013). As for digital technology adoption, according to the survey sample, Greek manufacturing firms appear to perform in general rather poorly concerning the usage of Big Data and data analytics as well as the introduction of new business models suitable for online operations, e.g. e-commerce and participative platforms. Moreover, controlling for a number of firm performance factors, we show that family firms are significantly less likely to adopt practices associated with the process of digital transformation. Finally, participation in GVCs is positively associated with innovation and adoption of digital technologies. According to the recent empirical literature, stronger participation in GVCs enhances the productive complexity of the domestic economy (Gereffi et al. 2005; Baldwin 2016; Taglioni and Winkler 2016), while establishing linkages in global production networks contributes to knowledge transfer and technology spillovers (Amendolagine et al. 2019).

The collection of our empirical findings provides ample fodder for concrete policy proposals to increase productivity in Greek manufacturing. First, education, skills and labour market policies should ensure that workers are equipped with the right skills and that businesses can flexibly deploy workers to meet changing labour market needs. The implementation of these policies will help ensure that technology adoption has a positive impact on both productivity and workers. Persistent skills gaps and mismatches come at economic and social costs, while skills constraints can

negatively affect labour productivity and hamper the ability to innovate and adopt technological advances. Second, Greece's low performance in innovation and knowledge diffusion points to an urgent need for a long-term national strategy, aimed at enhancing innovation, knowledge and technological capabilities, resting on the triplet of innovation and R&D, fostering of skills, and knowledge-intensive entrepreneurship. Innovation is a catalyst for sustainable long-term growth and therefore countries require a long-term national strategy involving the implementation of an effective innovation system, which promotes interaction among stakeholders and networking between knowledge creators and those willing to promote and commercialise research results and technical ideas.

The structure of the paper is as follows: Section 2 provides an in-depth analysis of skills challenges in Greece, including a review of skills indicators, as well as an analysis of the empirical relationship between skills mismatch and firm productivity. Section 3 considers management practices in Greek firms, benchmarks their performance and identifies the relationship between management quality and productivity. Section 4 presents the findings from the LIEE/NTUA survey. Section 5 concludes and provides some policy recommendations.

2 THE ALIGNMENT OF SKILLS WITH JOB REQUIREMENTS IN GREECE

2.1 SKILLS INDICATORS

Several types of skills matter in a digitalised economy: (i) advanced technical skills for digital specialists; (ii) generic digital skills for other workers; and (iii) complementary skills to work in a digitalised environment, including general cognitive skills, interpersonal skills, as well as managerial and organisational skills (OECD 2016; Grundke et al. 2018; Deming 2017). Both initial education and subsequent training have a role to play in enhancing these skills.

To date, most EU Member States, including Greece, have responded to the challenges posed by different drivers of skills demand by seeking to increase skills supply, notably through raising educational attainment. Notably, Greece has experienced an increase in tertiary education attainment over the last decade: in 2020, 44.2% of adults aged 25-34 had completed tertiary education, against 32.7% in 2010 (OECD 2020a). This is in line with projections of future skills demand shifting towards more highly skilled economic activities, as around half of all job openings over the next decade are expected to require a high qualification (Cedefop 2020). However, while levels of educational attainment in Greece have increased over time, there are concerns that the education and training system is not sufficiently aligned with labour market needs. In fact, university education is frequently criticised for not conferring upon its graduates the cutting-edge skills that the labour market needs.

In other words, one of the major problems facing the Greek labour market is the relatively large share of low-skilled population. Indeed, Greece had one of the lowest overall scores in the European Skills Index (ESI) survey of 2022, only marginally improving its performance relative to 2020 (from 20 to 23). The total score of 23% indicates that Greece has covered 23% of the way to achieving the ideal performance.[2] This low ranking is attributed to low scores in each of the three ESI pillars, pointing to a relatively weak skills system in Greece on multiple fronts.

Greece scores poorly in both digital and general skills. According to Eurostat data, in 2019

2 The European Skills Index (ESI) is Cedefop's composite indicator measuring the performance of EU skills systems. The ESI measures countries' "distance to the ideal" performance. This ideal performance is chosen as the highest achieved by any country over a period of 7 years. The ideal performance is scaled to be 100 and the scores of all countries are then computed and compared to that. The ESI consists of three pillars: skills development; activation; and matching, each of which measures a different aspect of a skills system. To illustrate, an index (or pillar, sub-pillar, etc.) score of 65 suggests that the country has reached 65% of the ideal performance. Thus, there is still 35% (100-65) room for improvement. A score of 100 corresponds to achieving the "frontier", that is an aspirational target performance for that indicator. A score of 0 corresponds to a lowest-case performance.

only 51% of the Greek population is equipped with basic or above digital skills (EU-27: 56%). Greece ranks 25th among EU-27 countries as regards the digital economy and society index (DESI) for 2021, although considerable efforts have been made to upgrade its digital infrastructure.[3] Moreover, the share of ICT specialists in total employment barely reached 2.8%, i.e. the lowest among EU-27 countries, despite some progress in the past three years. At the same time, according to data from the OECD Survey of Adult Skills (PIAAC),[4] only about one in 20 adults in Greece attains the highest levels of proficiency in literacy, compared with around one in ten adults (10.6%) on average across OECD countries, and similarly for numeracy.[5] Moreover, only 2.5% of adults in Greece attains the highest proficiency level in problem-solving in technology-rich environments. This is the fourth-lowest percentage observed among all participating countries/economies and significantly lower than the OECD average of 5.4%.

Looking ahead, it is essential for individuals to have sufficiently strong and versatile initial skills, so as to be able to succeed in an environment of fast-changing technologies and increasingly long working lives. More broadly, "foundational skills" such as literacy and numeracy are important prerequisites for the development of the skills demanded in the digital economy (OECD 2016). However, Greek school-age students perform just as badly as adults in skills measurement relative to international peers. In the latest standardised benchmark OECD PISA test, Greek students performed near the bottom among EU peers in mathematics, reading and science.[6] What is more troubling, performance has been deteriorating over time, suggesting scarring effects from the crisis. Greece has also one of the widest performance gaps between private and public schools, which is troubling about the role of education as a way for disadvantaged students to succeed.

The low skills level of the Greek economy means that employers may be unable to fill vacant positions because of skills gaps or shortages (lack of employees with suitable skills or qualifications), making this mismatch between the supply of and demand for skills a significant impediment to potential growth. However, mismatch may also characterise existing employment relationships. On-the-job mismatch refers to situations where there are discrepancies between the skills and qualifications of employees and the skills/qualification requirements of their job. The efficient matching of workers across jobs is also a crucial determinant of productivity. The fact that workers differ in their skills endowment, and hence relative productivity, across jobs gives rise to differences in comparative advantages of different workers across different tasks, in a Ricardian sense (Acemoglu and Autor 2011). These discrepancies may also arise due to differences in the quality of skills developed through training, or skills depreciation over the lifecycle and changes in skills demands. An efficient labour market needs to match workers of heterogeneous skills endowments across jobs of heterogeneous skills requirements. Labour market mismatch refers hence to situations where it is possible to shift workers across jobs and increase productivity, by improving the efficiency of resource allocation. An efficient allocation of workers across tasks is particularly important when the aggregate skills supply is relatively limited, as is the case for Greece. For the rest of the paper, it is this type of mismatch that we will refer to.

Mismatch has been variously measured in terms of skills, qualifications, or field of study (McGuinness 2006; Leuven and Oosterbeek 2011; Quintini 2011). Overskilling has been argued to be a more accurate measure of mis-

3 During the COVID-19 pandemic, the switch to online learning faced many challenges and highlighted the risk of exclusion for disadvantaged students. However, Greece has made significant steps in digitalisation, and digital education has become a policy focus. See European Commission (2020).
4 https://www.oecd.org/skills/piaac/.
5 Literacy scores measure reading comprehension and information processing ability in a professional environment, through standardised tests. Similar scores apply to numeracy.
6 https://www.oecd.org/pisa/test/.

match than overeducation (McGuinness and Wooden 2009). Data from the PIAAC suggest that Greece suffers from a high level of mismatch between the skills workers possess and those demanded of their jobs. Around 28% of workers are more proficient in literacy than their job requires (overskilled), the largest proportion across all participating countries/economies and much higher than the OECD average of 10.8%. At the same time, around 7% of workers are less proficient than required for their job (compared with the OECD average of 3.8%) and can be considered underskilled. Moreover, almost four out of ten workers in Greece are either over- or underqualified for the work they are doing. As for field-of-study mismatch, which measures the extent to which workers, typically graduates, are employed in an occupation that is unrelated to their principal field of study, almost one in two workers (41.4%) is employed in a different field than the one in which they earned their highest educational qualification.

Mismatch is damaging for workers, as it likely entails lower job satisfaction and a wage penalty, given that overskilled workers earn lower wages than workers with similar proficiency but who are well-matched with their jobs (Adalet McGowan and Andrews 2015). Overskilled workers' skills may not be valued or recognised if they are in jobs that require lower proficiency. Furthermore, firms may also incur higher training and hiring costs, in addition to reduced productivity and growth potential. One could argue that the expansion of higher education unavoidably leads to higher rates of overqualification. However, different factors may be at play, including policies that promote the alignment of education and training systems with the labour market, as well as policies supporting labour mobility (Vandeplas and Thum-Thysen 2019).

2.2 SKILLS MISMATCH AND LABOUR PRODUCTIVITY

In line with theoretical predictions, mismatch has been shown to be significantly negatively related to labour productivity. Adalet McGowan and Andrews (2015) argue that while hiring an overskilled worker may be beneficial to a firm, it may have negative consequences on the economy if skilled labour is trapped in unproductive firms. Mismatch can also impact average within-firm growth, since not only is the productivity of the marginal worker higher in more productive firms, but these firms can also grow faster if resources are reallocated towards them (Decker et al. 2017). If firms were homogeneous, misallocation would matter much less.[7] However, firms with radically different productivities co-exist in the market (Syverson 2004). In a well-functioning economy, resources would flow to more productive uses, resulting in a positive allocative efficiency term for the more productive economies. In fact, research has shown that differences in allocative efficiency are important in explaining differences in aggregate productivity across countries (Bartelsman et al. 2013; Hsieh and Klenow 2009).

We use PIAAC data to more precisely examine why Greece performs so poorly. The literature typically focuses on separating over- and underskilling; we dig deeper and further distinguish between both types of mismatch, as they pertain to different types of occupations. In particular, the survey asked workers whether they feel they "*have the skills to cope with more demanding duties than those they are required to perform in their current job*" and whether they feel they "*need further training in order to cope well with their present duties*". Overskilled workers are those whose proficiency score is higher than that corresponding to the 95th percentile of self-reported well-matched workers —i.e. workers who neither feel they have the skills to perform a more demanding job nor feel they need further training in order to be able to perform their current jobs satisfactorily— in their country and occupation. Underskilled workers instead are those whose proficiency score is lower than that corresponding to the 5th percentile of self-

7 In particular, if firms were homogeneous within a sector, then only sectoral misallocation would matter.

reported well-matched workers in their country and occupation.

We distinguish between highly skilled ("professional") jobs and all other jobs. The professional category includes occupations in ISCO occupational groups 1 to 3, and we group all other categories together. Ideally, a finer categorisation would have been preferable, allowing us to consider different types of skills, rather than this crude binary classification, but the sample size is not sufficient to do this. Literacy proficiency is our proxy for skills, as per common practice.

Chart 1 shows that Greece has by far the highest professional overskill mismatch (i.e. those working in highly skilled jobs are more proficient in literacy than their job requires) compared with all other countries in the sample. Most surprisingly, while in virtually all countries overskill mismatch is much lower for professional occupations than for lower-skilled jobs, the opposite holds for Greece. Even for lower-skilled jobs, overskill mismatch in Greece is high compared with other EU countries, although it is much closer to the sample average. Similar results are obtained when using skills mismatch in numeracy and controlling for sector and firm effects.[8]

We corroborate our findings using the European Working Conditions Survey (EWCS), which has also been used to study overskilling (Pouliakas 2014). In the EWCS, individuals are considered overskilled if they report that they "*have the skills to cope with more demanding duties*" in their own work and underskilled if they report that they "*need further training to cope well with duties*". Greece scores at the very top across the EU for overskilling, with higher values for professional jobs, while the other countries display, on average, similar values across job types. Despite some design differences between the EWCS and the PIAAC, both surveys highlight that mismatch is indeed a first-order problem for the country. Overskilled workers —those with higher skills than required by their jobs— tend to underuse their skills, resulting in a waste of human capital (OECD 2013).

Given the above evidence of high mismatch in professional occupations in Greece, we now turn to examine the importance of overskill mismatch in professional occupations relative to others. There are still no conclusive results in the literature as to whether mismatch in professional jobs is more detrimental to productivity than overall mismatch. In principle, professional jobs are knowledge-intensive and combine high levels of on-the-job learning and match-specific human capital. For example, software developers or chemical engineers require a substantial amount of job-specific training, while their marginal productivity can vary widely across firms, due to the various complementarities involved in these jobs. Moreover, if the supply of professional skills is lower relative to other skills, then search costs for finding or replacing workers for these positions will be higher than for positions requiring less formal training. Skills shortages may also be more binding for highly skilled occupations. Finally, discrimination is expected to be more important for professional occupations. While the importance of human capital in economic growth is well-founded, the importance of its allocation has only recently been recognised. Hsieh et al. (2019) recently showed that removing entry barriers for vulnerable groups (women and minorities) in high-skilled occupations in the United States resulted in higher per capita output by 20-40% through improved talent allocation.

We follow Adalet McGowan and Andrews (2015) and use the Olley-Pakes (1996) method to split aggregate productivity in each sector into a within-firm component and an allocative

8 It should be noted that there is a concern that the high overskilling observed in Greece may simply reflect classification noise. This is because for Greece the thresholds used to classify the appropriate skill levels for each position are determined using a small number of individuals. However, Greece has the largest dispersion in literacy scores out of all countries in the sample. This implies that applying higher thresholds for overskilling (e.g. those that are used for Spain or Italy), Greece would still have high values of mismatch in professional jobs.

Chart 1 Skills mismatch for high-skilled and low-skilled occupations

(share of employment)

Source: OECD, Survey of Adult Skills (PIAAC).
Notes: Overskilled workers are those whose proficiency score is higher than that corresponding to the 95th percentile of self-reported well-matched workers, i.e. workers who neither feel they have the skills to perform a more demanding job nor feel the need of further training in order to be able to perform their current jobs satisfactorily, in their country and occupation. Underskilled workers are those whose proficiency score is lower than that corresponding to the 5th percentile of self-reported well-matched workers in their country and occupation. High-skilled, medium-skilled and low-skilled occupations are ISCO occupational groups 1-3, 4-8 and 9, respectively.

efficiency component. Specifically, aggregate sectoral productivity is given by:

$$P_j = \sum_{i \in j} \theta_i P_i = \bar{P}_j + \sum_{i \in j} (\theta_i - \bar{\theta}_j)(P_i - \bar{P}_j)$$

In the expression above, P_j is the weighted sum of productivity of all firms in sector j, the within-firm component $\bar{P}_j$ is the (unweighted) average firm productivity in the sector, and the weight θ_i is given by the employment share of firm i in the sector. The final term is the allocative efficiency component, given by the covariance between relative firm size and relative productivity. If more productive firms are larger, then this is positive and indicates that resources flow to their more productive uses.

We combine cross-country data to explore the direct relationship between skills mismatch – aggregated from PIAAC microdata and sectoral labour productivity indicators, constructed from firm-level Orbis data.[9] Our sample includes 17 countries: Austria, Belgium, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Italy, Japan, Korea, Latvia, Sweden and Slovenia. We use data for ten sectors: manufacturing; electricity, gas, steam and air conditioning supply; water supply; construction; wholesale and retail trade; transportation and storage; accommodation and food service activities; information and communication; professional, scientific and technical activities; administrative and support service activities. A substantial drawback of the PIAAC data is that some of the country-sector cells are small. This becomes even more of a problem when we consider differences across occupations. As such, when we look at mismatch for professional versus non-professional occupations, we merge utilities (electricity, gas, steam and air conditioning supply, and water supply), which have the smallest coverage, in a single category.

We estimate regressions of the following form to explore the link between labour productivity and mismatch:

$$productivity^{j}_{s,c} = \alpha + \beta\ mismatch^{j}_{s,c} + \delta_s + \varepsilon_{s,c}$$

The dependent variable is a labour productivity measure in country c and sector s and the regressor is skills mismatch at different levels of aggregation. We also include a sector dummy δ_s to control for structural time-invariant differences in productivity and mismatch. We do not include a country dummy since this would result in very little variation and would remove valuable information, as mismatch across sectors tends to be similar within countries.

We regress the three productivity measures (aggregate sectoral, allocative efficiency and average firm) on under- and overskill mismatch indicators at the sectoral level. Results are shown in Table 1, Panel A. In Column (1), the dependent variable is aggregate sectoral productivity. We see that the coefficient of overskilling is negative and highly significant; it is also negative for underskilling, although not significant. The economic magnitude of the relationship is quite sizeable: a one standard-deviation increase in overskilling, at the expense of well-matched workers (the omitted category), holding constant the share of underskilled workers, reduces weighted sectoral productivity by almost 10%.[10] Column (2) shows results for aggregate sectoral productivity on the shares of overskilled by occupation type (professional and other). We see that the coefficients for both occupation types are high and negative, although only the one for non-professional occupations is significant (at the 10% level). Note, however, that the variables are jointly highly significant, as these measures are highly correlated. To take this into account, in Panel B we also estimate the model for each occupation type, and we see that both are

9 The first wave of the PIAAC was run from 2011 to 2018. The Greek wave was conducted in 2015. All measures are averaged for each sector across 2009-13 to improve reliability. To improve on the representativeness of Orbis, we construct resampling weights from the OECD Structural and Demographic Business Statistics (SDBS) database.

10 Adalet McGowan and Andrews (2015) also examine the effect of qualification mismatch. This is not, however, an appealing notion for our purposes, since by construction overqualification is rare for professional jobs, i.e. this type of jobs always requires a university degree, at least for the younger cohorts. Moreover, the sample is not large enough to further refine qualification into e.g. advanced versus undergraduate degrees.

Table 1 Productivity and skills mismatch

Panel A: Joint regressions						
	Aggregate sectoral productivity		Allocative efficiency		Average firm productivity	
	(1)	(2)	(3)	(4)	(5)	(6)
Underskilled	-1.750 (-1.49)		0.206 (0.32)		-1.956 (-1.64)	
Overskilled	-1.521*** (-3.52)		-0.553 (-1.55)		-0.968* (-1.77)	
Overskilled, professional		-0.646 (-1.54)		-0.142 (-0.67)		-0.504 (-1.03)
Overskilled, other		-0.780* (-1.78)		-0.535 (-1.50)		-0.245 (-0.40)
Observations	163	146	163	146	163	146
R-squared	0.667	0.589	0.501	0.522	0.462	0.368
Panel B: Separate regressions for each occupation type, overskilled						
Overskilled, professional	-0.874*** (-2.31)		-0.298 (-1.54)		-0.576 (-1.30)	
Overskilled, other		-1.052* (-2.61)		-0.595* (-1.85)		-0.457 (-0.81)
Observations	146	146	146	146	146	146
R-squared	0.584	0.584	0.510	0.521	0.368	0.364

Sources: OECD Survey of Adult Skills (PIAAC) and Orbis.
Notes: Each set of columns corresponds to a regression of the respective productivity measure on covariates. Over- and underskilled workers are defined as in the text. Professional occupations are ISCO occupational groups 1 to 3. The table reports coefficient estimates and t-statistics (in parentheses). The estimation method is OLS with industry fixed effects. The lower part of each panel also reports the number of observations and the adjusted R-squared. The ***, **, and * marks denote statistical significance at the 1%, 5% and 10% levels, respectively.

highly significant. Columns (3)-(4) repeat the analysis for allocative efficiency, and (5)-(6) for average firm productivity. As their sum equals aggregate sectoral productivity, the sum of the coefficients in the odd (even) columns equals the coefficient in the odd (even) column for aggregate sectoral productivity. We see that the coefficients for overskilling are negative, but only significant for average firm productivity. Since the combined effect is highly significant, this is most likely due to low power.[11]

Overall, the results corroborate the findings of Adalet McGowan and Andrews (2015): overskilling has a negative effect on productivity. Any differences in our estimation results could be attributed to the fact that productivity data cover the period during and after the global financial crisis, unlike Adalet McGowan and Andrews (2015). In any case, regressions are only meant to be indicative, given the small cell sizes especially for the professional occupations. But the upshot is that overskill mismatch plays an important role for productivity, and overskilling in professional occupations, where Greece scores especially badly, is a major drag.

3 MANAGEMENT PRACTICES

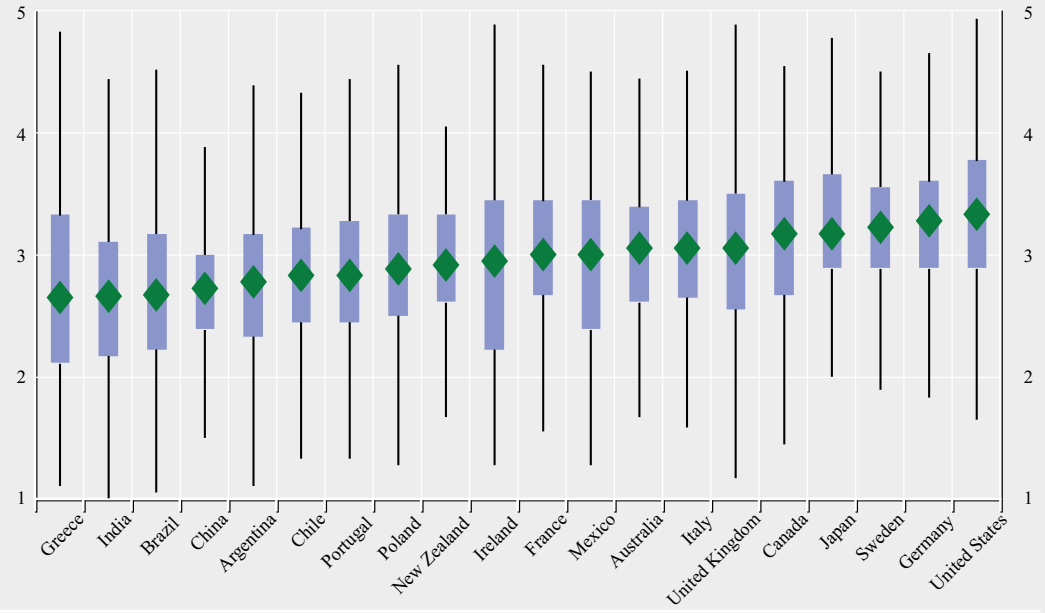
3.1 GREECE IN AN INTERNATIONAL CONTEXT

In this section, we analyse the managerial practices of Greek manufacturing firms and compare them with those of other countries around the world, with the aim to identify some lessons for policymakers in Greece on how to increase management quality and hence productivity.

11 Given the small sample size, we carried out a number of checks to ensure that the results are robust to outliers. We experimented with removing large residuals and ran several robust regression alternatives (quantile regression, M/MM and S estimators using the robreg routine in Stata). By and large, the results hold under these checks. The results are also virtually unchanged across specifications if we control for sector concentration with the HHI index.

Chart 2 Management scores across countries

(index from 1 to 5)



Source: World Management Survey (WMS).
Notes: Management scores, from 1 (worst practice) to 5 (best practice). Averages are calculated across all firms within each country. The green diamonds denote the mean, the blue bars denote the interquartile range and the black lines denote the 95% range.

We primarily rely on the World Management Survey (WMS), a large, internationally comparable management practices dataset (Bloom and Van Reenen 2007). The survey was based on randomly sampled, medium-sized manufacturing firms and sought to investigate the role of management practices in accounting for firm productivity differences across industries and countries.[12]

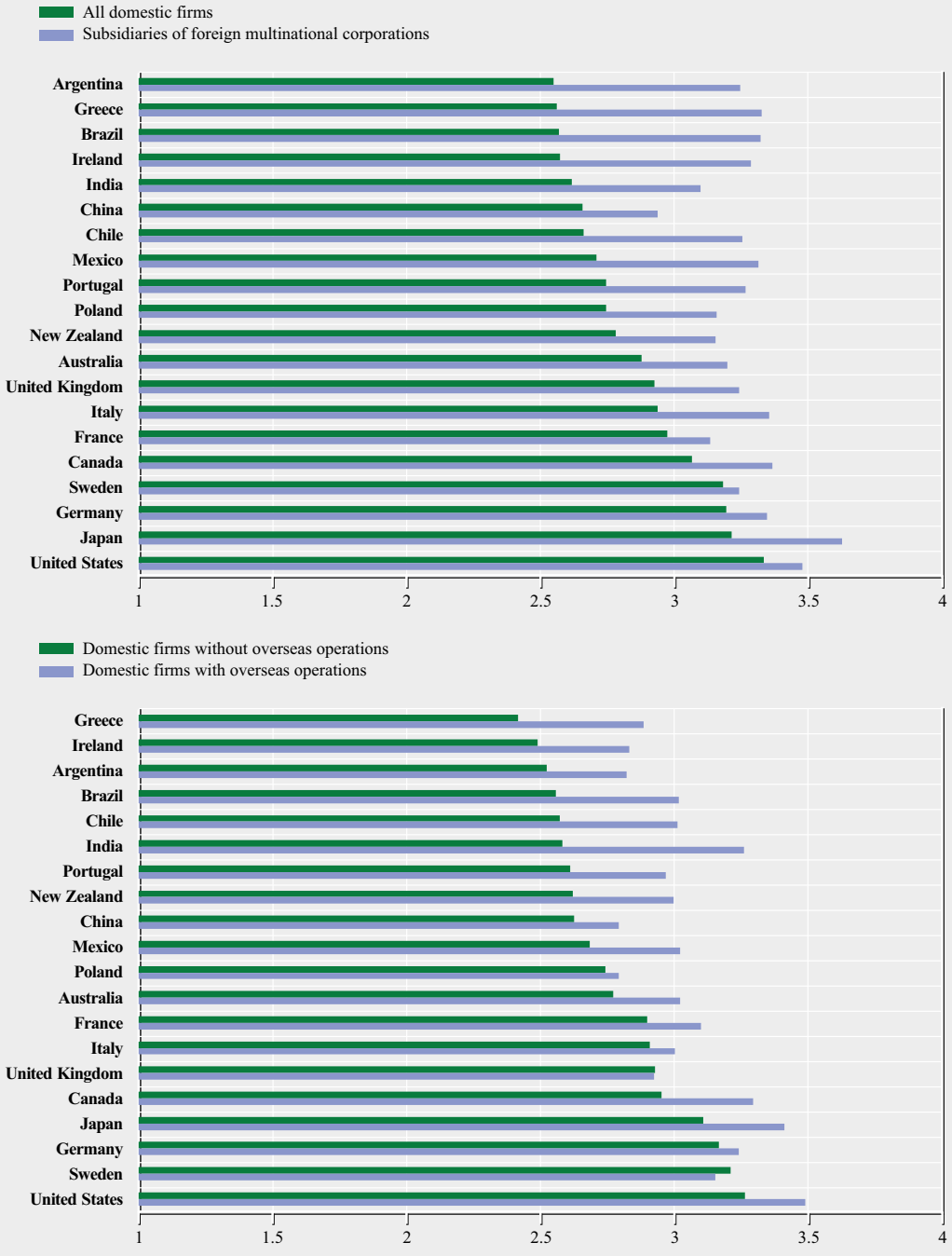
Though long ignored in the economics literature, management has risen as a key driver of growth. Bloom and Van Reenen (2007) found that higher management scores are positively and significantly associated with higher productivity and various aspects of higher firm performance. Bloom et al. (2009) further show that well-managed firms tend to imply better work-life balance and better facilities for workers. Similarly, Bloom et al. (2010) find that better firm-level management is associated with energy efficiency, while Bloom et al. (2013) provide some evidence of a positive causal relationship between better management and higher firm performance. Finally, Bloom et al. (2012) show that a one standard-deviation increase in management quality is associated with a 45% increase in labour productivity.

Chart 2 shows average management scores across advanced economies in the WMS sample. Greece scores last among other OECD and EU countries. Moreover, the quality of management practices in Greece is highly uneven. The high dispersion of management practices, together with a low average score, could give credence to the argument of little (or no) diffusion of good practices from leaders to laggards. The dispersion of management practices bears a clear similarity to the dispersion of productivity. A rich literature has documented that the dispersion of productivity is indicative of low resource reallocation and technology dif-

12 The survey was conducted across multiple waves for each country, from 2007 to 2014. The Greek wave was run in 2014.

Chart 3 Management scores across different types of firms

(index from 1 to 5)



Source: World Management Survey (WMS).
Notes: Management scores, from 1 (worst practice) to 5 (best practice). Scores averaged within countries, for each category.

fusion, and a key factor behind cross-country differences in productivity (Andrews et al. 2018; Decker et al. 2020). Bloom et al. (2019) show that differences in management practices

in the United Sates account for a similar (or larger) share of the variation in productivity as ICT, human capital and R&D. Indeed, Greece has been shown to have one of the largest dispersions in productivity in Europe (Gorodnichenko et al. 2018), which is suggestive evidence of the importance of management.

Delving into the drivers of dispersion in management practices in Greece, two features stand out. First, Greece has the largest gap in management practices between domestic firms and foreign multinationals operating in Greece (see Chart 3). This gap between domestic firms and subsidiaries of foreign firms is even higher than in Ireland, which features some of the leading multinationals in the world. More strikingly, these foreign multinational firms tend to score very well compared with multinationals in other countries. For example, a branch of a multinational firm domiciled in the United States and operating in Greece is managed as well as the branch of the same multinational operating in Sweden or France. This is both surprising and encouraging since it indicates that, despite the perverse regulatory and macroeconomic circumstances in the Greek economy, firms can find ways to be well-managed and hence productive (Genakos 2018).

Second, Greece also has one of the largest gaps (the largest in advanced economies) between domestic firms active in Greece only and domestic firms with overseas operations. Put another way, the productivity gap between domestic companies with overseas activities and those without is the largest in advanced economies. The direction of causality here is unclear. On the one hand, it is well-known that only the most productive companies have overseas activities (in terms of either exporting or having full-scale operations), and to the extent that more productive companies are better-managed, we would expect the gap to be large in a relatively low-productivity economy.[13] On the other hand, it is possible that foreign affiliates of Greek firms operating in countries with better management practices benefit from exposure to such practices, which they then import to Greece; such spillovers are common with knowledge-intensive inputs, such as management (Fons-Rosen et al. 2017). Either way, it is indicative of deep deficiencies in the management of Greek firms, but also underscores the potential for improvement.

We further examine how management styles differ in Greece compared with other countries. Similar conclusions are drawn even if we separate overall management score into its broad categories: lean operations; monitoring; target-setting; and talent management. Greece is consistently very near the bottom of the distribution across all four categories.

Table 2 shows the categories where Greece has the best and the worst performance, relative to the average. All five of the worst performing categories are broadly related to monitoring and talent management. Greek firms are lacking in performance tracking, clarity and comparability of goals, as well as process documentation, through which these goals can be achieved, and they also fail in developing talent and promoting high performers. These are intimately related: managers seem unable to set realistic goals and employ clear measures to gauge performance, which can result in an inability to reward and hence develop talent. These findings align well with common perceptions about human resource practices of Greek firms, as well as other evidence: for example, Greece ranks last among OECD countries in reporting job strain (OECD 2019b).

On the other hand, Greek firms appear to perform at par with firms in other countries in the scope and appropriateness of lean manufacturing techniques. They also score close to the overall average in talent retention and in creating a distinctive employee value proposition (employer attractiveness). These findings point to an interesting pattern: Greek firms do worst in issues

13 More precisely, if the productivity cut-off to operate overseas is more or less similar across countries, and the distribution of productivities is shifted to the left for Greece relative to other advanced economies, then the productivity gap of firms with overseas activities versus those without is expected to be larger in Greece.

Table 2 Greek firms' scores compared with firms in other advanced economies

Worst performer		Best performer	
Category	Standardised difference from other advanced economies' average	Category	Standardised difference from other advanced economies' average
Performance tracking	-0.5869	Introducing lean (modern) techniques	-0.0029
Developing talent	-0.5261	Retaining talent	-0.0101
Clarity of goals and measurement	-0.4574	Rationale for introducing lean (modern) techniques	-0.0186
Process documentation and continuous improvement	-0.4219	Creating a distinctive employee value proposition	-0.0393

Source: World Management Survey (WMS).

requiring people management, planning and oversight, or requiring synergies, dialogue and collaboration. They do best in issues requiring decision-making, possibly by a single individual.

A potential corollary of this finding is that Greek firms may also prevent their employees from exercising judgement and discretion, instead requiring them to follow strict rules and procedures and delegate to senior management. Such structures can inhibit firm growth, as larger firms require local decision-making and flexibility in responding to shocks.

To examine this hypothesis, we further augment our analysis on management practices with PIAAC data on questions about workplace attitudes, specifically on employee autonomy. Employees were asked to define their degree of freedom in choosing and/or changing the sequence, mode and speed of their tasks, and their working hours. A combined score of task discretion is then calculated given the answers to these questions, allowing for cross-country comparisons. Chart 4 shows the coefficients (along with 95% confidence intervals) from a regression of the overall score of employee autonomy on country, firm-size and sector-occupation dummies (excluding the self-employed) to account for structural differences across countries. The coefficients are given in differences relative to Finland, which is the top performer. We see that Greece scores last, lagging almost one standard deviation below the top. We confirm the robustness of this finding through a relevant question in the WMS, which measures the autonomy of plant managers in hiring, investment, product and pricing decisions. Greece scores very low in this dimension as well.

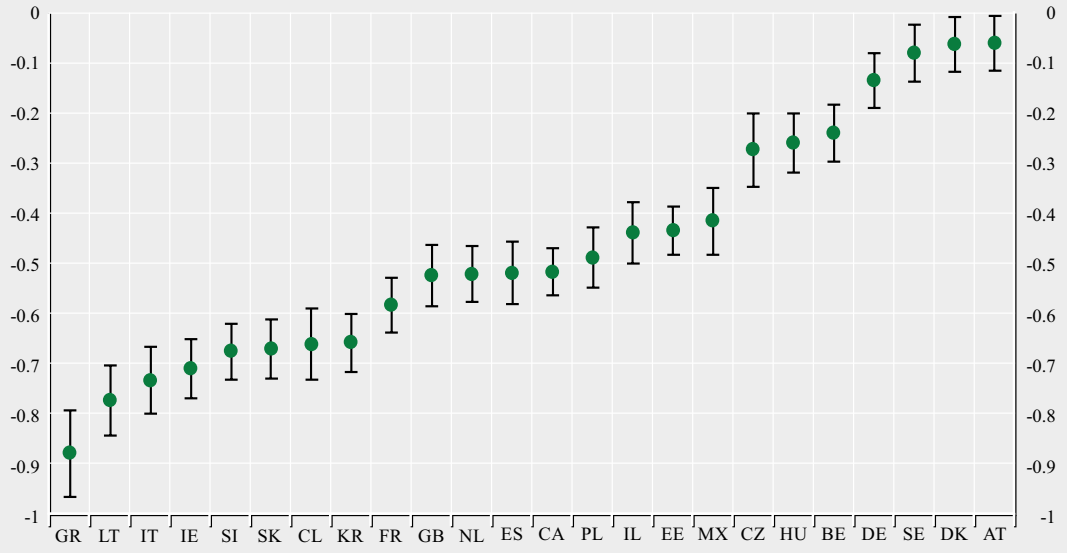
We have provided empirical evidence that Greek managers do best in issues related to decision-making, which may not require any delegation, and worst in issues requiring teamwork and cooperation, while allowing little employee autonomy relative to their peers. These findings are consistent with low levels of trust between firms and workers, and could also correspondingly signal little attachment to the job, low accumulation of human capital, and eventually low productivity and wage growth. This can also have considerable consequences for the viability of small firms when, for example, the founder retires and the succeeding generation shows weak corporate governance and lower managerial quality.

The literature has documented the important benefits of decentralised decision-making and high employee autonomy, as well as how lack of trust can impede such arrangements.[14] A decentralised organisational structure, which gives agency to workers and local managers to

14 Culture, more generally, has been shown to be a non-trivial determinant of a variety of economic forces. See Guiso et al. (2006) for a review.

Chart 4 Employee autonomy

(raw scale from 1=lowest autonomy to 5=highest autonomy, relative to the top performer)



Source: OECD, Survey of Adult Skills (PIAAC).
Notes: The chart shows the coefficients (along with 95% confidence intervals) from a regression of the overall score of employee autonomy on country, firm-size and sector-occupation dummies (excluding the self-employed) to account for structural differences across countries. The coefficients are given in differences relative to the top performer (Finland).

make decisions, has been linked to positive outcomes in a variety of ways. Bloom, Sadun and Van Reenen (2012) posit that higher social trust facilitates delegation of authority to workers, which can indirectly affect productivity, primarily through its interaction with factors of production. For instance, decentralised firms may be able to employ IT solutions better through experimentations. More importantly, decentralisation is a necessary condition to allow firms to grow beyond a certain size. Decentralisation can also help firms withstand shocks. In volatile environments, the value of local knowledge may be more important than the ability of a chief executive to issue centralised decisions. In fact, Aghion et al. (2021) use WMS data and show that decentralised firms were much more resilient in turbulent markets during the global financial crisis.

The lack of autonomy also relates to lack of flexibility in work arrangements, a particularly salient feature of the pandemic. Recent evidence shows that firms implementing policies to stimulate flexibility and job autonomy are more likely to innovate (Azeem and Kotey 2021; Krammer 2022; Giannetti and Madia 2013). At the same time, working time flexibility is also thought to increase workers' well-being, by giving them more control over their working hours and better opportunities to balance their work and family life. Despite the potential risk of moral hazard problems, as employees might abuse their discretion, the literature finds that working time autonomy improves individual and firm performance (see for example Beckmann (2016) and references therein). In the same vein, Godart et al. (2017) show that companies adopting trust-based working hours (which is a form of flexible working time) are more likely to improve their products and to undertake process innovation. Therefore, innovation and working time flexibility seem to be related with technological innovation (especially ICT), favouring the development of flexible working time arrangements and new forms of work organisation (Erhel et al. 2021).

Hence, if managers pay attention to the restrictions mentioned above when implementing working time autonomy policies, such policies are promising tools at their disposal. Combining job autonomy with performance monitoring and target-setting could potentially act to enable an innovative workplace, offering better working time conditions and satisfaction for workers, while preserving managerial oversight. This is not to say of course that decentralisation is always optimal. Indeed, there is a trade-off between autonomy and close supervision (Aghion and Tirole 1997). However, different industries have different decentralisation requirements, and such low structural levels of autonomy may be detrimental to the development of these industries.

These findings concur with comparable cross-country data (European Social Survey), as tabulated by Bloom et al. (2012), which place Greece at the lower end of European countries when it comes to trust. Gartzou-Katsouyanni (2021) conducts a number of case studies of local communities in the tourism and agri-food sectors in Greece, and identifies characteristics that can catalyse cooperation despite low levels of trust. Trust can also affect the attitudes of prospective employees, with important implications for the challenge of attracting expatriated Greek workers. Tasoulis et al. (2019) survey a sample of skilled Greek workers working in Greece and abroad, and find that workers in Greece have negative views about the intentions of both small and large firms in Greece, but much higher regard for the competencies of large firms. Workers abroad not only have a higher opinion of foreign firms across both aspects, but they have more positive views on foreign firms across both dimensions than on Greek firms, irrespective of size. The perceived lack of meritocracy is also a key reason for preventing expatriated workers from returning.

3.2 MANAGEMENT PRACTICES AND LABOUR PRODUCTIVITY

Having established some empirical regularities of the management practices of Greek firms, we now proceed to empirically examine how these relate to productivity. As discussed in Bloom and Van Reenen (2010), it is important to recall that clearly establishing the causal effect of how changes in management affect productivity is not possible. Nevertheless, examining the association between measures of management and firm performance in terms of productivity is an important first step in determining the extent to which management practices are economically meaningful. To this end, we merge WMS data for Greece with 2017 Orbis financial data. This yields a dataset of 282 unique firm observations, of which 235 are from the 2014 wave of the WMS and the rest is from the 2006 wave.

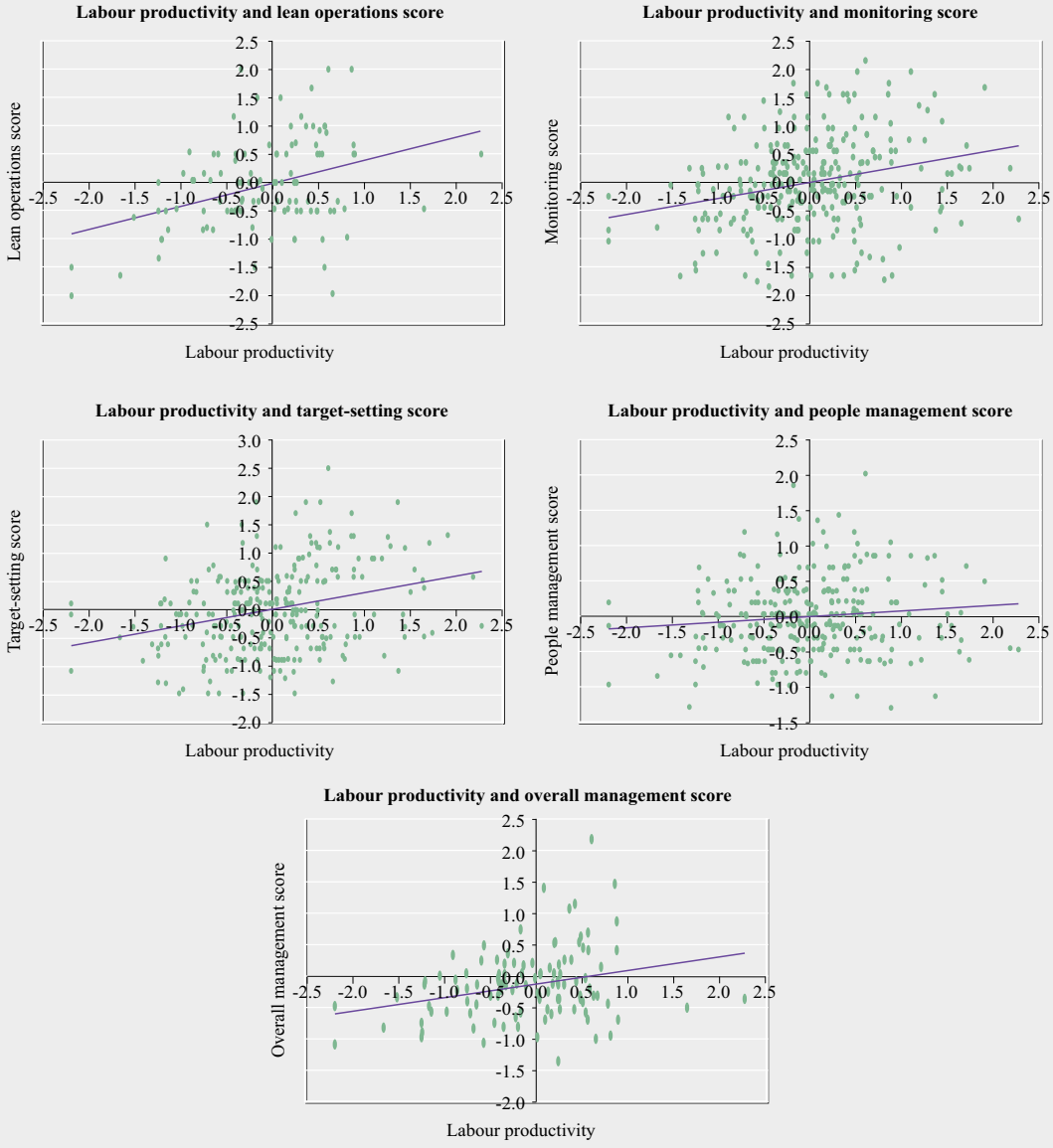
The majority of firms are in manufacturing (94.3%), with more than 40% belonging to the food, beverages and tobacco sector. More than

Table 3 Summary statistics of management scores

	Mean	Median	Min.	Max.	St. Dev.
Overall management	2.745	2.667	1.278	4.833	0.614
Lean operations	3.068	3	1	5	0.862
Monitoring	2.980	3	1	5	0.83
Target-setting	2.592	2.6	1	5	0.768
People management	2.57	2.5	1.167	4.5	0.57

Sources: World Management Survey (WMS) and Orbis.
Notes: Overall management (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on www.worldmanagementsurvey.com.

Chart 5 Management scores and labour productivity



Sources: World Management Survey (WMS) and Orbis.
Notes: Overall management (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on www.worldmanagementsurvey.com. Labour productivity is defined as the natural logarithm of operating revenue divided by the number of employees.

two thirds of the sample are medium-sized firms (50-249 employees), whereas 5% of the sample are small firms (less than 50 employees). Larger firms perform better in all management practices and across sectors (see Chart A1 in the Appendix). Almost a quarter of the firms (23%) are part of a multinational enterprise. These firms exhibit higher average scores in all management categories (differences-in-means are statistically significant at 1%, as shown in Table A1 in the Appendix). Table 3 shows summary statistics for our sample across management categories. The mean management score in our sample is just below 3.

We examine the association between the overall management score and the four broad categories of management practices, and firm performance in terms of productivity. We compute labour productivity as the natural logarithm of operating revenue divided by the number of employees and apply 1% winsorisation. Graphical evidence is given in Chart 5, where we plot productivity against management scores, controlling for an industry dummy variable, dummies for firm age (using three age classes), size, multinational ownership and exporting status. The full results are presented in Table A2 in the Appendix.

Across all measures, we see that better-managed firms are more productive. For the aggregate management score (the average across all 18 questions), the coefficient suggests that firms with a one standard-deviation higher average management score have about 15 log points higher labour productivity, which is a sizeable difference. The relationship between productivity and management is strong across all subcategories of management indicators. It is not significant only for people management, possibly because the support is quite compressed (at very low levels by international standards), implying little variation.

Overall, given the well-established relevance of management for productivity, the above findings are particularly troubling as regards the long-run growth prospects of the Greek economy. For instance, poor management implies a lack of appropriate structure to take advantage of existing human capital. It also implies an inability to appreciate the benefits from the adoption of new technologies, techniques and processes, as well as a lower innovation potential. As such, it may be more of a burden in ICT-intensive sectors, given that ICT capital requires a more complex set of inputs beyond just machines and equipment (Bresnahan et al. 2002). In general, the literature has pointed out that the inability of European firms, especially in Southern Europe, to exploit the potential of ICT is an important factor behind lacklustre growth over the past two decades (Pellegrino and Zingales 2017; Schivardi and Schmitz 2020).

4 INNOVATION AND TECHNOLOGY ADOPTION

Innovation is a catalyst for sustainable long-term growth, and countries need a long-term national strategy involving the implementation of an effective innovation system, which will promote interaction among stakeholders and networking between knowledge creators and those willing to promote and commercialise research results and technical ideas (Hansen and Birkinshaw 2007). This in turn stresses the need for knowledge-intensive entrepreneurship (Malerba and McKelvey 2018). Finally, a national strategy requires an international outlook, as globalisation has placed international supply chains at the heart of modern policies.

At the same time, a focal point for the recovery and resilience of the Greek economy is the digitalisation of private enterprises, as well as of the public sector (Bai et al. 2021; OECD 2020b). In 2021, Greek firms lagged in the adoption of digital practices, and this lag characterises almost all facets covered by the European Commission's Digital Transformation Scoreboard (European Commission 2019). The Greek economy stands at the bottom end of the distribution in all key metrics concerning digital transformation, digital maturity and digital skills, according to the Digital Maturity Index constructed by SEV (Deloitte and SEV 2020).

Against this background, the aim of this section is to examine structural characteristics of (i) innovative versus non-innovative firms, and (ii) firms that are in the forefront of digital technologies. We focus on the role of size, family firm versus non-family firm, participation in GVCs and talent management since these have appeared to play an important role in firms' innovation behaviour. First, Greece has one of the largest shares of SMEs within the EU (99.92% in 2019 compared with 99.81% for the EU-27) and most of them are family businesses.

Hence, given that, as suggested by previous empirical evidence from other countries, firm size is strongly related with innovation (Hall et al. 2009; Rogers 2004; Coronado et al. 2008) and given that it is also generally accepted that family involvement in ownership affects firm innovation behaviour (Carnes and Ireland 2013; Matzler et al. 2015), it makes sense to look further at these two characteristics. Moreover, according to the latest OECD data, Greek enterprises appear not to have established significant forward and backward linkages within the globalised production systems, which could hinder their technological transformation. The causal direction of this strong association is unclear. This could be due to the fact that technological sophistication is a necessary condition for participation in GVCs, as synchronisation of production and harmonisation of organisational practices are easier in technologically advanced firms. On the other hand, knowledge spillovers along the value chain may expose local firms to good practices, facilitating technology adoption. Antràs (2020) argues that GVCs involve networks of firms with common goals, making them a fertile ground for technology transfer. Although empirically establishing either of these hypotheses in a credible manner is exceptionally challenging, some recent evidence seems to support the spillover hypothesis (Rigo 2021), while the overall positive effect of trade on technology transfer is also established (Coe and Helpman 1995; Antràs 2020; Keller 2021). Finally, harnessing workforce skills through sound human resource (HR) management practices is a key enabler of technological upgrading and, ultimately, productivity growth, an issue that has already been singled out for the Greek manufacturing sector (Caloghirou et al. 2020).

We focus our analysis on the 2019 LIEE/NTUA Survey on entrepreneurship, technological developments and regulatory change supported by the Hellenic Federation of Enterprises (SEV). The LIEE/NTUA Survey dataset provides extensive information on firm-specific details, including among other things innovation activity, technology adoption, GVC participation and HR practices, for a representative sample of manufacturing firms in Greece. The survey sample includes 1,014 Greek firms, of which 1,001 have a valid VAT number. 22% are micro enterprises (fewer than 10 employees), 57.2% are small enterprises (10-49 employees), 11.3% are medium-sized enterprises (50-99 employees) and 9.5% are large enterprises (100 or more employees[15]). Family firms account for 63% of the sample, with no pronounced deviation across firm sizes.

We first summarise some of the responses concerning innovation activity. As shown in Chart 6, about half of the firms in the sample engage in product innovation, 26% engage in organisational innovation (including marketing) and 31% have introduced a process innovation. Strikingly, more than one out of three firms (38%) do not report any innovation activity. However, the overall share of firms in the survey reporting at least one aspect of innovation is 63%, which is in line with the results of the Community Innovation Survey (CIS) 2016-18 published by Eurostat, in which 62% of enterprises in manufacturing reported innovative activities.[16]

Moreover, 33% of firms in the sample collaborate for activities associated with R&D and innovation. This is much higher than the 19% reported in the CIS, but it is broadly in line with e.g. the European Innovation Survey, in which collaboration among innovative firms is considered as a strong attribute in the case of Greece. Finally, 27% of firms in our sample report to have established an in-house R&D department.

Turning now to the role of size, we see that two out of five micro firms report product innova-

15 Given the negligible representation of firms with more than 250 employees (2.7% of the sample), we consider firms with more than 100 employees as large enterprises for the purposes of our analysis.

16 Similarly, 44% of manufacturing firms participating in the CIS report product innovation, which is also in line with our findings. The share of manufacturing firms with innovative activity in at least one of the areas of marketing, accounting, logistics, or production process is above 50%, which however is not directly relatable to our findings shown in Chart 5.

Chart 6 Innovation activity of Greek manufacturing firms

(% of respondents)

Sources: LIEE and Orbis.
Note: The relevant questions in the LIEE/NTUA survey are: (i) Does your firm have an R&D department? (ii) Has your firm introduced new products or services over the past two years? (iii) Has your firm introduced innovations referring to production processes or routines? (iv) Has your firm collaborated with other firms or organisations for innovation over the past two years? (v) Has your firm introduced innovations referring to organisation, marketing or sales over the past two years?

tions, whereas the respective share of large enterprises is 64%. Process and organisational innovations show similar patterns across firm sizes. The CIS 2016-18 is in support of our findings: less than 50% of firms with less than 50 employees are innovative, 70.5% of firms with 50-249 employees are innovative, and 87% of large firms are innovative. This holds true for all aspects of innovation. Many scholars have argued that small firms are the engines of technological change and innovative activity, at least in certain industries (Acs and Audretsch 1988;

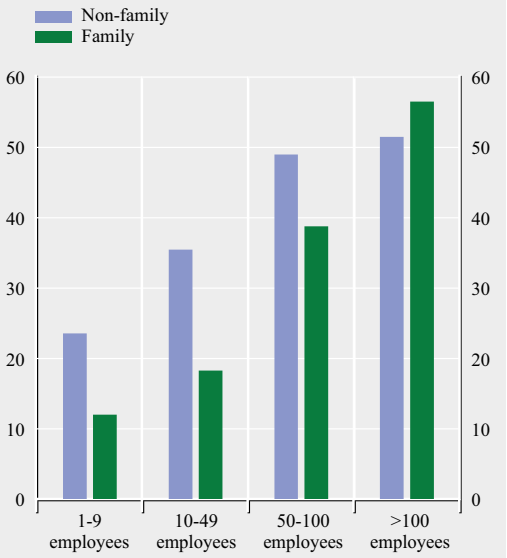
1990). Moreover, according to the European Commission's European Innovation Scoreboard, product and process innovations are areas in which Greece is classified as a strong innovator, despite being a modest innovator based on its overall innovation performance.

Interestingly, there are no pronounced differences between family and non-family firms in any of the three innovation categories. On the other hand, as shown in Chart 7, there is heterogeneity across size and family ownership concerning the establishment of an R&D department, which is considered as evidence of persistent innovation activity. Family ownership plays a role even within size-cluster, and this is only reversed for large firms, with more than half of large firms reporting to have an R&D department, irrespective of ownership type (family versus non-family).

As for digital transformation, firms were prompted to respond on a Likert scale (1-5), where 1 stands for "do not use at all" and 5 stands for "use to a great extent", to several questions concerning the usage of digital technologies. Chart 8 reveals that a very small share of firms has adopted cutting-edge digital technologies: Greek manufacturing firms perform rather poorly in the usage of Big Data and data analytics, as well as in the introduction of new business models suitable for online operations, e.g. e-commerce and participative platforms. Weak performance is pronounced in the case of 3D printing, with more than 80% of the participating firms replying that they have not used that particular technology at all. However, firms perform somewhat better regarding advanced software for organising production (CRM, ERP, CAD/CAM), access to new generation networks, such as cloud services, and use of advanced communication systems with customers, partners and suppliers (e.g. e-invoicing, digital procurement, blockchain). Overall, at least half of the firms respond "do not use at all" or "do not use nearly at all" in all six questions regarding the adoption of digital technologies. The low adoption of digital technologies corroborates SEV's Digital

Chart 7 R&D department across sizes and ownership types of Greek manufacturing firms

(% of respondents)



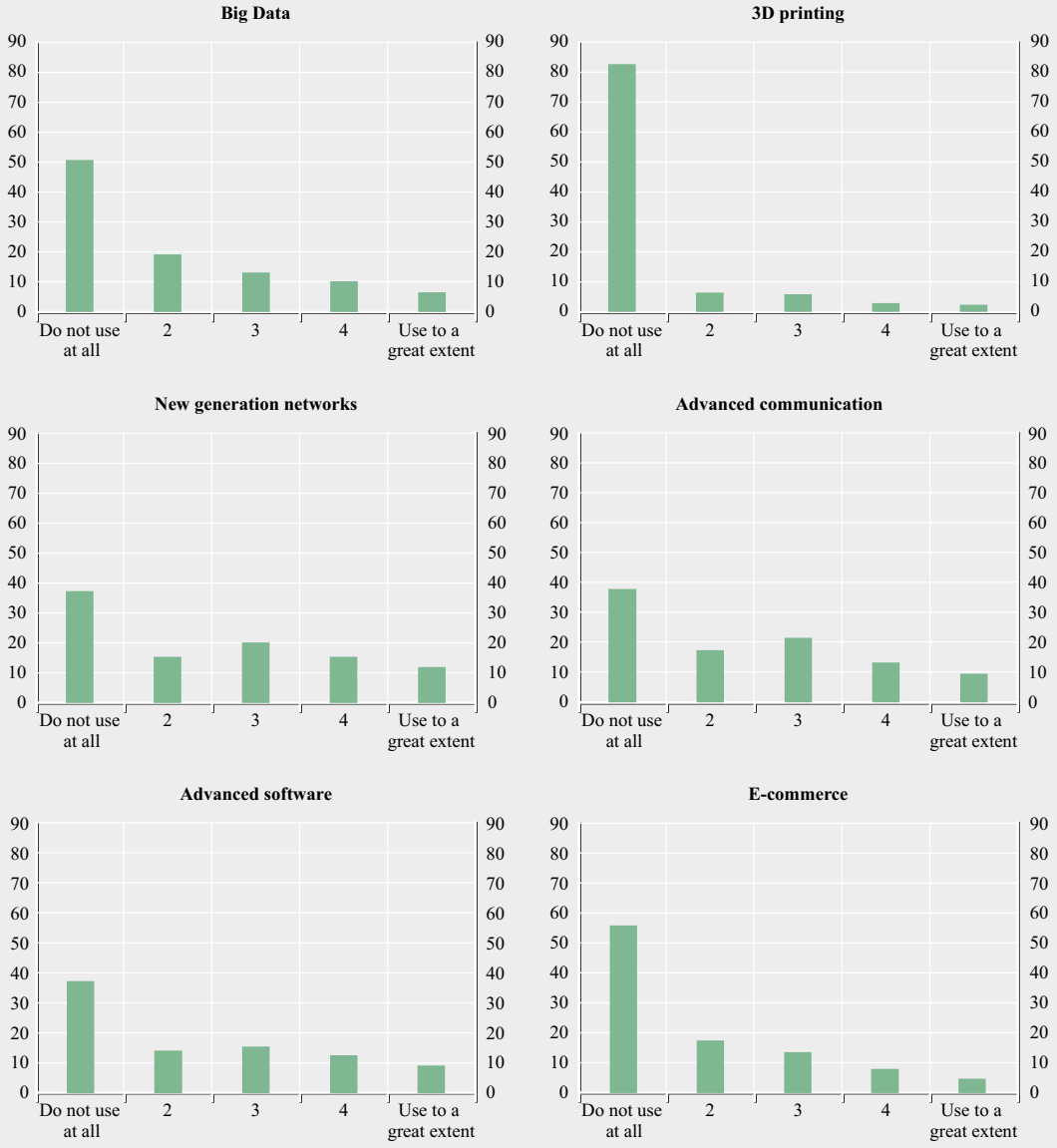
Sources: LIEE and authors' calculations.

Maturity Index for 2019, according to which Greece is a laggard in the fields of digital e-commerce, cybersecurity and use of online networks.

To examine whether being a family firm is associated with technology adoption, we estimate an ordered logit regression, controlling for GVC participation, R&D collaboration and firm size. Chart 9 depicts the average marginal effect of family ownership on the adoption of digital technologies (Table A3 in the Appendix presents the full results). There is a significant negative relationship between being a family firm and adoption of digital technologies, as measured by five out of the six relevant questions. Family firms are significantly less likely (at the 5% level) to adopt practices associated with digital transformation, except for advanced software to organise production, which however is not a new technology compared with, for example, Big Data or 3D printing. On the other hand, a micro enterprise is 13 percentage points less likely to report no e-commerce services if it is family-owned, relative to other micro enterprises.

Chart 8 Adoption of digital technologies by Greek manufacturing firms

(% of respondents)

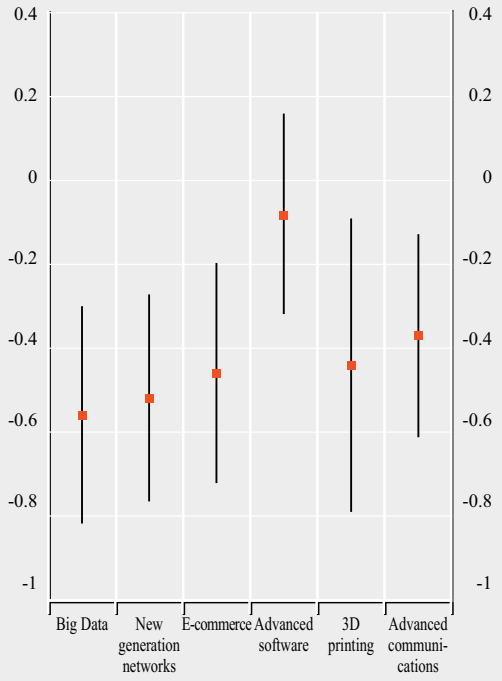


Sources: LIEE and authors' calculations.

Moreover, it should be mentioned that, in general, most of the sample firms appear not to have harnessed the full potential of the 4IR: one in three firms is not at all informed about the 4IR and 36% respond that although they are informed about and wish to participate in the 4IR, they have not formed a concrete action plan (see Chart 10). Another striking result is that smaller size and family ownership are not only negatively associated with digital adoption, but also with the extent to which the firm is prepared for the 4IR. Specifically, 6% of family firms respond that they have already reaped the full potential of the 4IR compared with 23.5% of non-family enterprises. As for the reasons impeding the adoption of 4IR tech-

Chart 9 Marginal effect of family firm on the adoption of digital technologies

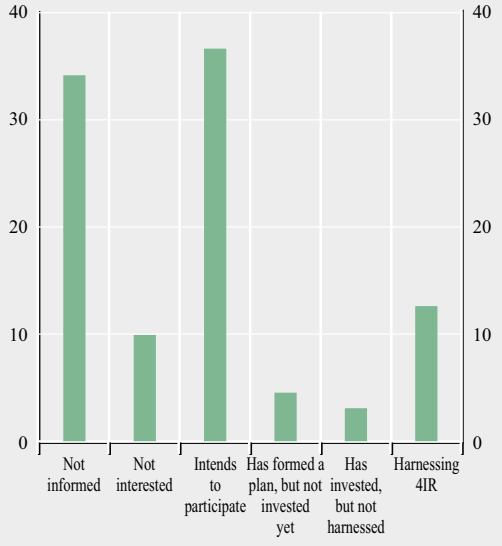
(average marginal effect)



Sources: LIEE and authors' calculations.
Note: The lines denote 95% confidence intervals.

Chart 10 4th Industrial Revolution (4IR) of Greek manufacturing firms

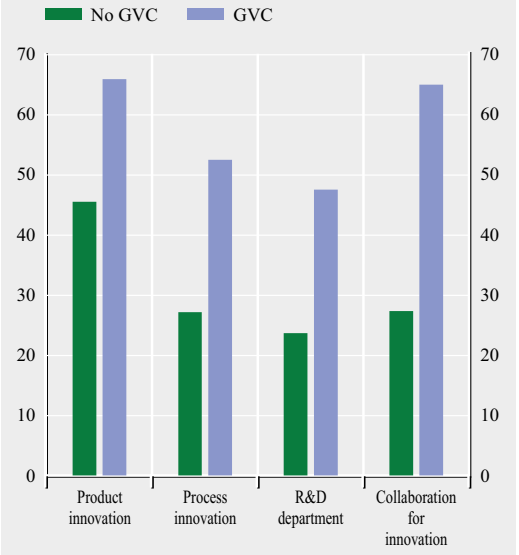
(% of respondents)



Sources: LIEE and authors' calculations.

Chart 11 GVC participation and innovation activity of Greek manufacturing firms

(% of respondents)



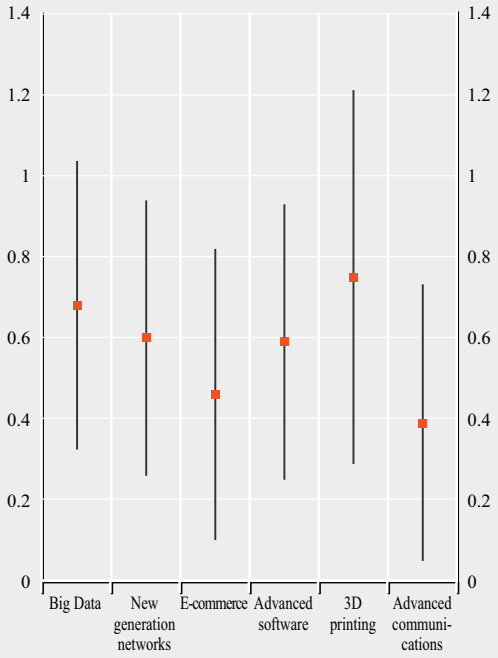
Sources: LIEE and authors' calculations.

nologies, a quarter of the firms notes the lack of financial support, a fact more pronounced for small firms (40% compared with 13% for large firms) and family firms (36%). SMEs typically do not have enough financial and human resources for in-house innovation activities (Dufour and Son 2015). Surprisingly though, we find that one in three firms underscores the lack of skills as a minor or negligible obstacle.

Indeed, the slow and limited transmission of knowledge identified in Greek manufacturing has been partly attributed to the sparse participation in GVCs. Chart 11 highlights the interconnection of GVC participation and innovative activity. Participation in GVCs is associated with enhanced innovation performance: two out of three firms participating in GVCs report product innovations and more than half of them report process innovations. The results are robust across firm sizes, with greater GVC participation differentials for larger firms. In addition, the share of GVC participating firms that fully foster the potential of the 4IR is 18.4%, as opposed to 11.3% otherwise. Participation in GVCs is also positively associated with the

Chart 12 Marginal effect of GVC participation on the adoption of digital technologies for Greek manufacturing firms

(average marginal effect)



Sources: LIEE and authors' calculations.
Note: The lines denote 95% confidence intervals.

adoption of digital technologies in terms of all six relevant survey questions. Chart 12 shows the average marginal effect of GVC participation on the adoption of digital technologies stemming from an ordered logit model controlling for sector and firm size. The effect is statistically significant at the 1% level for five out of the six questions (Table A3 in the Appendix presents the estimation results).

Finally, two interesting general results emerge concerning skills and HR practices. First, four out of five firms state that their employees possess the skills required to leverage digital technologies, at least to some extent. This is somewhat surprising and could imply that managers are now aware of the necessary skills needed for digital transformation, as also evidenced by the large share of firms stating that they are not prepared for the 4IR. Second, and in line with the findings in Section 3, sound HR practices are not very widespread. Only 46% of firms respond that they have formal evaluation and reward processes for their employees, and a similar share invests in technologies aiming to upgrade employees' digital skills. Furthermore, 56% of firms reward employees for their innovative ideas and provide tangible incentives for innovation development, while 64% implement training and development programmes for employees. Table 4 indicates that family-owned firms tend to lag considerably in the adoption of HR practices that are connected to the digital transformation of the firm. The

Table 4 Human resource management practices, size and family ownership of Greek manufacturing firms

	Evaluation & reward			Innovation reward & incentives			Retraining programmes			Investment in HR digital upgrade		
	Non-family	Family	t-test	Non-family	Family	t-test	Non-family	Family	t-test	Non-family	Family	t-test
Firm size	(1)	(2)		(3)	(4)		(5)	(6)		(7)	(8)	
1-9 employees	0.573	0.344	***	0.646	0.463	***	0.732	0.44	***	0.61	0.28	***
10-49 employees	0.569	0.345	***	0.572	0.533	*	0.661	0.595	**	0.564	0.376	***
50-100 employees	0.830	0.356	***	0.787	0.559	***	0.766	0.78	**	0.723	0.525	***
> 100 employees	0.743	0.607	*	0.676	0.518	*	0.943	0.821	**	0.857	0.429	***
All firms	0.617	0.372	***	0.627	0.523	***	0.717	0.598	***	0.627	0.372	***

Sources: LIEE and authors' calculations.
Notes: Columns (1), (3), (5) and (7) report the mean of the variables for the sample of non-family firms. Columns (2), (4), (6) and (8) report the mean of the variables for the sample of family firms. For each respective pair, the t-test columns report statistical significance resulting from t-tests that are testing the mean difference between non-family versus family firms. *** p<0.01, ** p<0.05, * p<0.1.

relationship is strong for all HR practices and across all different firm size categories (except for retraining programmes for firms with 50-100 employees).

5 CONCLUSIONS AND RECOMMENDATIONS FOR POLICYMAKERS AND STAKEHOLDERS

In this study, we selected some important problem areas of Greek industry, which constrain the country's long-term economic prospects. In particular, we focus on skills, management practices, innovation, and technological adoption of Greek firms and establish new empirical facts using international datasets (PIAAC, WMS and Orbis) as well as some novel survey data (LIEE/NTUA).

On the skills front, our results show that, first, Greece has a considerable mismatch between supply of and demand for skills, which is a significant impediment to potential growth. Secondly, focusing on "on-the-job mismatch", we find that Greece suffers from a high level of mismatch between the skills workers possess and those demanded of their jobs. Furthermore, distinguishing between over- and underskilling in highly skilled ("professional") jobs and all other jobs, we show that Greece has the highest professional overskill mismatch compared with all other countries in the sample. As opposed to all other countries, this mismatch is higher for professional occupations than for all other jobs in the case of Greece. This implies that overskilled workers tend to underuse their skills, resulting in a waste of human capital. Finally, we show that a one standard-deviation increase in overskilling, at the expense of well-matched workers, reduces weighted sectoral productivity by almost 10%.

The results reveal that there is a need to improve the alignment of workers' skills with the needs of industry, in terms of enhancing both skills endowment and the allocation of current skills to jobs. The key message is that the various policies should be closely coordinated and integrated into an intelligent and inclusive industrial policy for both higher and vocational education and training (VET). More precisely, some strategic initiatives should be carefully designed and implemented. We suggest the following:

Policy 1: Establishing and promoting university-industry cooperation schemes. This will help link the needs and problems of manufacturing firms with the valorisation/commercialisation of academic research. This is a clear double dividend: the industry will address skills shortage by tapping and forming the exact type of human capital it requires, while reducing brain drain. In this context, joint programmes to pursue diploma theses and industrial doctoral dissertations in fields of common interest should be designed and implemented.

Policy 2: Maintaining balance between formal education, in-firm training and lifelong learning. The Greek skills development system is characterised by academically oriented formal education and limited in-firm training. Participation in lifelong learning is also low. There is an urgent need to invest in human capital before and after entry into the labour market and in particular in upskilling and reskilling, due to the rapid technological and organisational changes. In this regard, a balanced mix of training and lifelong learning schemes by large industrial firms, business associations and academic institutions should be launched and funded.

Policy 3: Maintaining balance between formal and tacit curricula in Greek universities. A variety of joint activities in addition to the formal curriculum could be developed systematically, with a view to strengthening students' business acumen. Examples are industrial visits, internships for students as a degree requirement, career days, joint workshops dealing with specific industrial problems, mentorship programmes, etc. Such initiatives can reduce the acute problems of adverse selection in job search, as students are unfamiliar with the work environment and the needs of industry before graduation, and thus improve the matching process.

Policy 4: Promoting student networks —as part of the broader university activities— can serve similar goals. In particular, this can include volunteer networks, student groups dealing with issues related to their studies, their scientific discipline, or industry and business evolution, conferences, training summer schools and workshops, and exploration of different career paths.

Policy 5: Upgrading secondary and upper secondary technical-vocational education and training. This is an essential step to ensure that students' skills meet the needs of industry. Apprenticeships are required for many trades and can take different forms. The Swedish approach, for instance, involves students completing a three-year-long vocational education in upper secondary school, followed by a post-secondary apprenticeship in a particular trade (Fjellström and Kristmansson 2019). Another approach incorporates vocational training directly into upper secondary school through an apprenticeship, along with a carefully established apprenticeship curriculum (to ensure that educational goals are not overlooked). An eclectic approach is warranted, depending on the needs of different sectors.

On the management practices front, we show that Greece has the lowest average management score compared with other OECD and EU countries. Moreover, the quality of management practices in Greece is highly uneven. Two features stand out as key drivers of this dispersion: (1) Greece has the largest gap in management practices between domestic firms and foreign multinationals operating in Greece; and (2) Greece has the largest gap in advanced economies between domestic firms active only on the domestic market and domestic firms with overseas operations. Overall, we show that Greek firms perform worst in issues requiring people management, planning and oversight, as well as synergies, dialogue and collaboration. They do best in issues requiring decision-making, possibly by a single individual. Further analysis of those issues reveals that Greece scores last in terms of employee autonomy. Given the high share of family-owned firms, this points to a corporate culture tied around the founder, leaving little room for talent development and firm decentralisation. Finally, the results show a positive relationship between management quality and firm performance in terms of productivity for Greek manufacturing firms.

While this is a particularly challenging area to improve, because it would conflict with the inner workings of firms, we suggest the following:

Policy 6: Engaging in changing business culture and management practices in Greek manufacturing firms, i.e. through specific in-firm training programmes, by purchasing external services or by experimenting in new management practices and relevant organisational schemes.

Policy 7: HR departments should focus on the managerial skills of firm employees and the selection processes of managers at different levels.

Policy 8: Dealing in a professional way with the problem of succession in Greek family firms. This is arguably the most difficult, but also the most important task. A particularly useful model for Greece, taking into account its societal structure, is the German Mittelstand, where family-held firms are typically run by professional managers outside the family.

Policy 9: Promoting joint ventures and other forms of cooperation between professionally organised and managed firms and traditional family-managed firms.

On the innovation and technology adoption front, the results show that firm size has a positive and significant relationship with product innovation. While the role of family-owned firms is not significantly related with firm performance, the results suggest that those firms are less likely to (i) have an in-house R&D department and (ii) adopt practices associated with the process of digital transformation. Both those factors are indicators of persistent innovation activity. Greek firms are also shown to

lack usage of Big Data, data analytics and new business models suitable for online operations. Finally, we show that participation in GVCs is positively associated with innovation and adoption of digital technologies.

In this regard, linking research with innovation and further activating knowledge-intensive entrepreneurship (startups, spinoffs, spinouts and mature firms) as well as corporate entrepreneurship could be a driver for upgrading the innovative capacity of the Greek industrial system (Pissarides Commission 2020; dianeosis/LIEE at NTUA 2021). We suggest:

Policy 10: Establishing a bottom-up technology transfer initiative. An especially successful example is the Commission for Technology and Innovation (CTI) in Switzerland, which provides coaching, networking and financial support to academic and private research initiatives, in order to create viable commercial ventures. Econometric investigation has found strong evidence that the CTI has improved the productivity, sales and R&D intensity of treated firms (Arvanitis et al 2013; Beck et al. 2016). The Swiss model is especially attractive for Greece, because it does not feature a leading role for the central government, which only acts in a coordinating capacity, and instead allows for bottom-up initiatives by various actors. As such actions have already started to materialise in Greece (e.g. the Science Agora knowledge transfer hub, or the partnership of SEV with NTUA and the National Centre for Scientific Research "Demokritos"), it would be wise to foster and allow such a system to flourish, rather than imposing a top-down approach. In this regard, policy could encourage the creation of industrial research fora between academia and industry.

Policy 11: Improving university administrator capacity. This is key to the diffusion of academic research into industry, most notably including technology transfer offices (TTOs), which have been inaugurated lately. At the same time, it is essential to enhance innovation and entrepreneurship initiatives and units, which can expose scientists to ways in which their research can be commercialised and teach entrepreneurship to students, as well as promote the newly established Competence Centres,[17] which aspire to organise and streamline university resources.

Moreover, a number of policy measures for the development, diffusion and absorption of knowledge should be designed and implemented:

Policy 12: Accelerating the transition of businesses to the 4th Industrial Revolution, by preparing, launching and implementing a 4IR strategy for Greece.

Policy 13: Strengthening domestic value chains and corresponding sectoral productive ecosystems, as well as encouraging cooperation among small and medium-sized enterprises (SMEs).

Policy 14: Enhancing the participation and upgrading the role of Greek companies in global value chains and their connection with sources of knowledge of other innovation systems.

Policy 15: Bolstering regional innovation systems in the context of a smart specialisation strategy.

Policy 16: Supporting the "corporate innovation system" (Granstrand 2000), with large business centres that will act as a test-bed for small and startup companies, as well as research teams of universities and research centres.

Policy 17: Building the capacity of public bodies to conduct procurement, aimed at developing innovation (Public procurement of innovative solutions − PPI),[18] and enhancing their digital capabilities and the provision of electronic services.

17 Competence Centres are public-private sector structures created to bridge the gap between supply and demand for specialised innovation services and technology transfer in one or more value chains. For Greece, see for example http://www.antagonistikotita.gr/epanek_en/prokirixeis.asp?id=40&cs.

18 https://digital-strategy.ec.europa.eu/en/policies/ppi.

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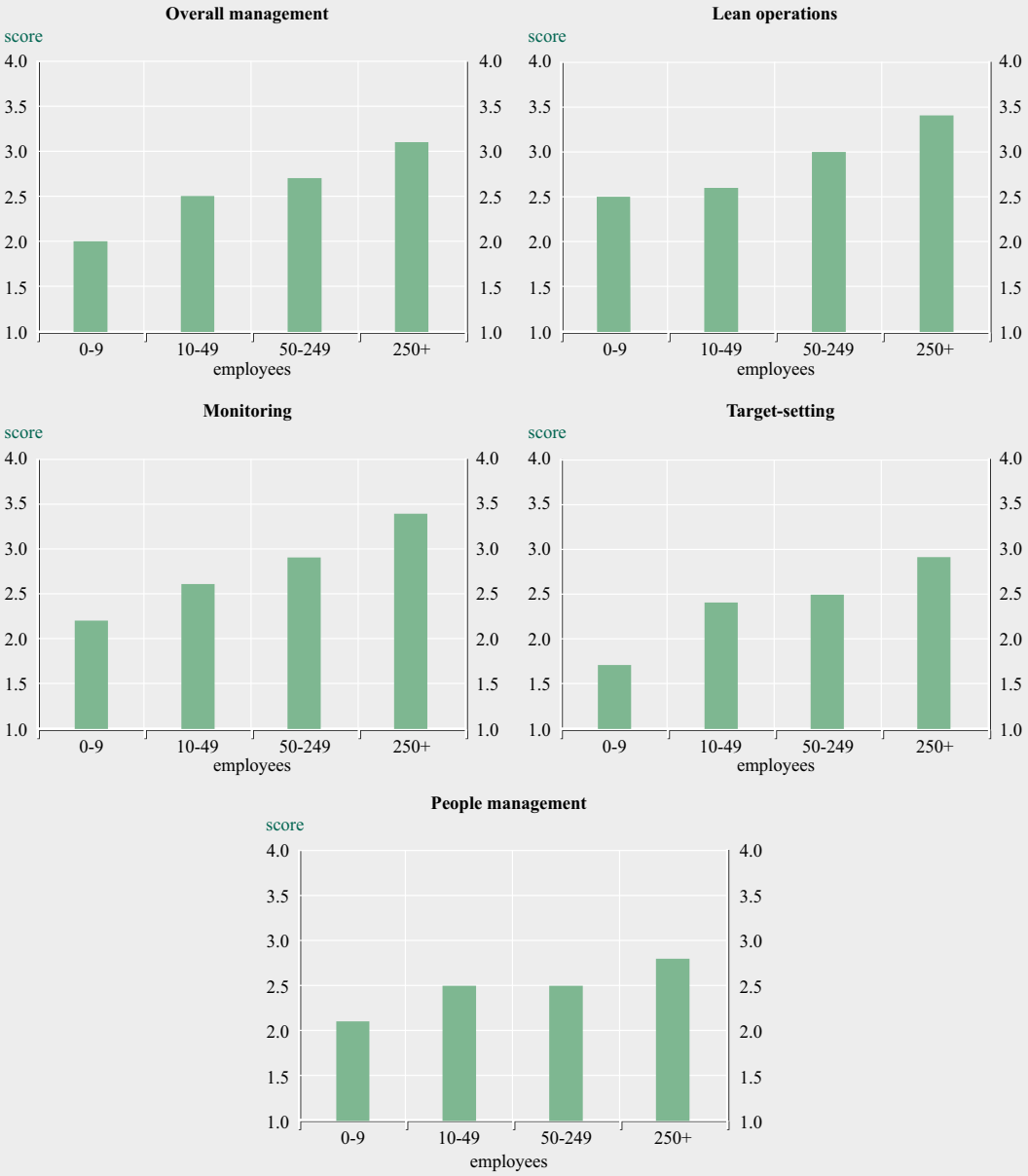
APPENDIX

Chart A1 Management scores by firm size of Greek manufacturing firms



Sources: World Management Survey (WMS) and Orbis.
Notes: Overall management (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on www.worldmanagementsurvey.com.

Table A1 Management index and multinational ownership

WMS indicator	No multinational ownership (1)	Multinational ownership (2)	Difference (3)	Standard error	t-test
Overall management	2.608	3.192	-0.585	0.080	***
Lean operations	2.917	3.554	-0.637	0.117	***
Monitoring	2.814	3.503	-0.690	0.111	***
Target-setting	2.446	3.079	-0.634	0.102	***
People management	2.468	2.914	-0.446	0.076	***

Sources: World Management Survey (WMS) and Orbis.
Notes: Overall management (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on www.worldmanagementsurvey.com. Columns (1) and (2) report the mean of the variables for the sample of firms with and without multinational ownership, respectively. Column (3) reports the difference between (1) and (2). The t-test column reports statistical significance resulting from t-tests that are testing the mean difference. *** p<0.001, ** p<0.005, * p<0.1.

Table A2 Management score and productivity

	Overall management	Lean operations	Monitoring	Target-setting	People management
	(1)	(2)	(3)	(4)	(5)
Management score	0.247*** (0.072)	0.163*** (0.057)	0.159*** (0.052)	0.193*** (0.053)	0.104 (0.076)
Multinational ownership	0.233** (0.091)	0.253*** (0.095)	0.264*** (0.092)	0.253*** (0.087)	0.302*** (0.095)
Age 10-19 years	0.557*** (0.159)	0.559*** (0.160)	0.691*** (0.147)	0.519*** (0.161)	0.551*** (0.165)
Age 20+ years	0.901*** (0.095)	0.862*** (0.098)	1.013*** (0.087)	0.864*** (0.098)	0.880*** (0.105)
10-49 employees	-1.273* (0.716)	-1.102 (0.693)	-1.237 (0.758)	-1.305* (0.770)	-1.182 (0.764)
50-249 employees	-1.152 (0.700)	-1.045 (0.672)	-1.111 (0.741)	-1.182 (0.754)	-1.061 (0.747)
250+ employees	-1.136 (0.704)	-0.996 (0.676)	-1.090 (0.745)	-1.141 (0.760)	-1.002 (0.752)
Constant	11.949*** (0.730)	12.040*** (0.705)	11.990*** (0.762)	12.181*** (0.758)	12.259*** (0.777)
Observations	277	276	277	277	277
R-squared	0.416	0.415	0.410	0.415	0.394
Sector FE	Yes	Yes	Yes	Yes	Yes
Robust SE	Yes	Yes	Yes	Yes	Yes

Sources: World Management Survey (WMS) and Orbis.
Notes: The dependent variable for all models is labour productivity defined as the natural logarithm of operating revenue divided by the number of employees. Overall management (including all questions) and sub-indices of the questions covering each of the portions of the questionnaire (lean operations, monitoring, target-setting and people management). A full set of the questions can be found on www.worldmanagementsurvey.com. The estimation method is OLS with industry fixed effects. The lower part of the table also reports the number of observations and the adjusted R-squared. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A3 Family ownership, GVC participation and adoption of digital technologies for Greek manufacturing firms

	Big Data	New generation networks	E-commerce	Advanced software	3D printing	Advanced communications
	(1)	(2)	(3)	(4)	(5)	(6)
Family ownership	-0.56*** (0.13)	-0.52*** (0.13)	-0.46*** (0.13)	-0.08 (0.12)	-0.44** (0.18)	-0.37*** (0.12)
GVC participation	0.68*** (0.18)	0.60*** (0.17)	0.46** (0.18)	0.59*** (0.17)	0.75*** (0.25)	0.39** (0.17)
Collaboration for innovation	0.61*** (0.14)	0.75*** (0.14)	0.67*** (0.14)	0.53*** (0.14)	-0.21 (0.20)	0.52*** (0.13)
10-49 employees	0.13 (0.17)	0.28* (0.16)	0.15 (0.17)	0.57*** (0.16)	0.24 (0.25)	0.24 (0.16)
50-100 employees	0.65*** (0.24)	0.66*** (0.22)	0.43* (0.24)	1.01*** (0.22)	0.22 (0.33)	0.81*** (0.23)
>100 employees	0.67*** (0.25)	0.70*** (0.24)	0.46* (0.25)	1.25*** (0.25)	0.44 (0.34)	0.83*** (0.25)
Observations	872	890	885	893	887	890
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.0361	0.0360	0.0274	0.0318	0.0150	0.0229

Source: LIEE/NTUA.

Notes: The table reports the average marginal effect results (from ordinal logit regressions), whereby the dependent variable denotes agreement with five statements taking a score ranging from 1 (indicating that the respondent is not using the specific technology at all) to 5 (indicating that the respondent is using the specific technology to a great extent). A constant term is included in the regressions. The lower part of the table also reports the number of observations and the pseudo R-squared. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

POST-PANDEMIC INFLATION: PHILLIPS CURVE, TRENDS, DRIVERS AND LESSONS

Christos Catiforis
Bank of Greece, Economic Analysis and Research Department

ABSTRACT

After several years of very low inflation, the world economy in 2021 and 2022 has been confronted with an abrupt and persistent rise in inflation rates not seen for decades. This paper investigates the main factors behind the surge in consumer price inflation in advanced economies and possible differences across them. It assesses the relative role of excess demand arising from the reopening of economies after the COVID-19 restrictive measures, global value chain and supply-side disruptions, higher energy prices, the "base effect", and labour market pressures. We find that prices were initially pushed up by the fast world demand recovery combined with global supply disruptions, but eventually, especially since the war in Ukraine, energy prices have become the main driver of increased inflation. Differences in the contribution of the core inflation component across advanced economies, especially between the United States and the rest, reflect differences in output gaps and labour market tightness, while unit labour cost pressures remained muted almost everywhere. Given that inflation is expected to remain elevated for longer than initially anticipated, monetary authorities are expected to become more "conservative" again, defending their credibility. Past experience suggests that, as the economic slowdown becomes inevitable, the short-term costs of a gradual and orderly monetary policy normalisation to activity and employment are probably lower than the potential longer-term costs of a more popular prolonged accommodative policy. The anchoring of inflation expectations is not a free lunch.

Keywords: inflation; Phillips curve; COVID-19 pandemic; supply disruptions; energy prices; monetary policy

JEL classification: E31; E5; Q43

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ΠΛΗΘΩΡΙΣΜΟΣ ΜΕΤΑ ΤΗΝ ΠΑΝΔΗΜΙΑ: ΚΑΜΠΥΛΗ PHILLIPS, ΤΑΣΕΙΣ, ΑΙΤΙΑ ΚΑΙ ΔΙΔΑΓΜΑΤΑ

Χρίστος Κατηφόρης
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

ΠΕΡΙΛΗΨΗ

Μετά από πολλά έτη αρκετά χαμηλού πληθωρισμού, η παγκόσμια οικονομία το 2021 και το 2022 βρίσκεται αντιμέτωπη με μια απότομη και επίμονη άνοδο του πληθωρισμού σε επίπεδα που έχουν να παρατηρηθούν εδώ και δεκαετίες. Η παρούσα μελέτη ερευνά τους κύριους παράγοντες που προκάλεσαν αυτή την άνοδο του πληθωρισμού τιμών καταναλωτή στις προηγμένες οικονομίες, καθώς και τις πιθανές διαφορές μεταξύ των επιμέρους οικονομιών. Αξιολογεί το σχετικό ρόλο της υπερβάλλουσας ζήτησης η οποία προέκυψε με την επανεκκίνηση των οικονομιών μετά τα περιοριστικά μέτρα λόγω της πανδημίας, των διαταράξεων στις διεθνείς αλυσίδες αξίας και στην πλευρά της συνολικής προσφοράς, των υψηλότερων τιμών της ενέργειας, των επιδράσεων του αποτελέσματος βάσης και των πιέσεων στην αγορά εργασίας. Διαπιστώνεται ότι οι τιμές ωθήθηκαν προς τα άνω αρχικώς από την ταχεία ανάκαμψη της παγκόσμιας ζήτησης σε συνδυασμό με τα προβλήματα στις διεθνείς εφοδιαστικές αλυσίδες, αλλά τελικά, ιδίως μετά την έναρξη του πολέμου στην Ουκρανία, ως κύρια αιτία ανόδου του πληθωρισμού αναδείχθηκε το κόστος της ενέργειας. Οι διαφορές μεταξύ των οικονομιών ως προς τη συμβολή του πυρήνα του πληθωρισμού στο γενικό πληθωρισμό, ιδίως μεταξύ των ΗΠΑ και των λοιπών προηγμένων οικονομιών, αντανακλούν διαφορές στο παραγωγικό κενό και στη στενότητα στην αγορά εργασίας, ενώ γενικά δεν παρατηρήθηκαν πληθωριστικές πιέσεις από το κόστος εργασίας ανά μονάδα προϊόντος. Δεδομένου ότι ο πληθωρισμός θα παραμείνει σε υψηλά επίπεδα για μακρότερο χρονικό διάστημα έναντι των αρχικών προβλέψεων, οι νομισματικές αρχές αναμένεται ότι θα ξαναγίνουν περισσότερο "συντηρητικές" με στόχο τη διαφύλαξη της αξιοπιστίας τους. Η ιστορική εμπειρία δείχνει ότι, καθώς η οικονομική επιβράδυνση καθίσταται πλέον αναπόφευκτη, το βραχυχρόνιο κόστος μιας σταδιακής ομαλοποίησης της νομισματικής πολιτικής επί του προϊόντος και της απασχόλησης ενδέχεται να είναι χαμηλότερο από το δυνητικό πιο μακροπρόθεσμο κόστος μιας περισσότερο δημοφιλούς παρατεταμένης διευκολυντικής νομισματικής πολιτικής. Η πρόσδεση και σταθεροποίηση των πληθωριστικών προσδοκιών δεν μπορεί να έρχεται ως "γεύμα δωρεάν".

POST-PANDEMIC INFLATION: PHILLIPS CURVE, TRENDS, DRIVERS AND LESSONS*

Christos Catiforis
Bank of Greece, Economic Analysis and Research Department

I INTRODUCTION

Inflation has become the number one macroeconomic problem of the global economy. After several years of moderate or even low inflation levels, the world economy has been confronted with an abrupt rise in inflation since the summer of 2021. Central banks in advanced economies have struggled for more than a decade to bring inflation up to target. Now, surprisingly, they face the opposite problem, i.e. how to tame inflation without hurting the economic recovery from the worst post-WWII recession ever recorded. This rise in headline inflation has already proved more persistent than initially perceived by policymakers, and inflation rates increased further during the first months of 2022, reaching a 40-year high in many advanced economies.

The quick reopening of economies and the lifting of pandemic-related restrictions led to a strong increase in aggregate demand, underpinned by pent-up demand and increased savings. Consumers and businesses started spending what they could not before due to the quarantines and the lockdowns imposed by governments to contain the pandemic. Unfortunately, aggregate supply failed to meet this increased aggregate demand due to global value chain disruptions and world trade frictions caused by the COVID-19 pandemic (Bank of Greece 2021a). Gradually, the main factor behind rising inflation came to be the higher energy prices and transport costs, after the abrupt surge in global demand for energy, as the economies exited fast the recession of 2020. Especially after the Russian invasion of Ukraine and because of the ongoing war, energy prices and inflation increased further, giving rise to reasonable concerns about the anchoring of inflation expectations and the possible reaction functions of monetary authorities in the bigger economies. According to the spring 2022 projections by international institutions, energy prices, as well as headline inflation will not recede before 2023 and will remain elevated at least for one more year.

The costs of high inflation were well-documented decades ago. High inflation lowers real incomes and spending, and exacerbates inequality by hitting more the poorer households, which normally do not possess other assets than cash and cannot enforce equivalent nominal increases in their salaries. Inflation erodes cash savings and often leads to currency depreciation and to a new spiral of inflation-depreciation through import prices. High and volatile inflation increases uncertainty and adversely affects business investment. It hinders optimal resource allocation by distorting relative prices. On the other hand, high inflation rates reduce the real burden of debt, private or public.

Inflation developments have already weighed on production costs and businesses, as well as on households' real disposable income, while creating uncertainties as to their temporary or longer-lasting nature. Projections for economic activity in 2022 and 2023 are already factoring in the consequences of high inflation, gradually revising downwards estimated growth rates in most countries. At the same time, monetary authorities, having opted for a highly accommodative monetary policy stance to support the recovery from the pandemic fallout until the end of 2021, are now shifting towards earlier monetary policy normalisation, aiming more aggressively for the objective of price stability over the medium term and safeguarding the credibility of monetary policy.

This article begins with the theoretical approaches of inflation determinants. Beside the monetary approach, the structural approach of supply-side factors is examined. A short

* The views expressed in this article are of the author and do not necessarily reflect those of the Bank of Greece. The author is responsible for any errors or omissions.

investigation into the relationship of inflation with employment and the output gap follows, questioning the existence and the explanatory power of the "Phillips curve". The article goes on to visit past inflationary episodes and to capture main long-run inflation trends and recent key developments across large economies. Then, trying to identify the main driver of this inflation episode, it discusses in more depth the inflationary pressures stemming from both the aggregate supply and demand sides. It examines the role of supply-side disruptions, energy prices and transport costs, the "base effect" argument, and labour market pressures. Lastly, some conclusions on the inflation outlook and the possible way forward for monetary authorities are formulated.

2 THEORETICAL APPROACHES TO INFLATION

Inflation causes and determinants have been explored extensively, both theoretically and empirically, especially following the two most famous inflation episodes in the post-war period, the two oil crises in 1973 and 1979. Through the 1980s, both Monetarists and Keynesian economists converged to Milton Friedman's famous statement back in 1963 that in the long run "Inflation is always and everywhere a monetary phenomenon". However, this conclusion that inflation is a monetary phenomenon did not settle the issue of what causes inflation in the short run and why monetary authorities choose an inflationary policy.

Many papers found evidence supporting the strong money supply-inflation relationship in the long run. Mishkin (1984) for instance found that the correlation between the average rate of inflation and the average rate of money growth for 52 countries over the decade 1972-82 was 0.96. Mishkin illustrated that increasing constantly money supply, in the context of the familiar aggregate demand (AD)-aggregate supply (AS) diagram, would translate into a parallel upward shifting of both the AS and AD curves, which would leave the economy with the same real output but with higher inflation. Mishkin finds therefore that the underlying cause of inflation in the United States was accommodative monetary policy geared to achieving higher employment. The role of expectations was important in the inflationary process, in the sense that in order to avert the resurgence of inflation at a minimum cost in terms of unemployment and output loss, monetary policy must be both non-accommodative and credible.

Fighting inflation effectively became top priority worldwide during the 1980s and 1990s. An independent, Rogoff-style conservative central bank with a welfare function that gives higher weight to low inflation than to low unemployment was widely accepted in advanced economies as a solution to the time consistency problem of inflation, delivering lower inflation even without trust and reputation effects which take time to build (Rogoff 1985).

The discussion on inflation in advanced economies shifted in the 2000s. Having controlled the inflation rates back to low levels two decades after the two oil crises, and with the EMU fully operating, a vast amount of literature tried to investigate the existence and persistence of inflation differentials within the euro area. Persistent inflation differentials may result from differences in equilibrium price developments across countries. These differences can be related to price differences between tradable and non-tradable sectors, which may reflect Balassa-Samuelson effects[1], different capital-labour ratios, or different income elasticities between sectors. Differences in equilibrium prices may also arise due to different structures and different degrees of market efficiency. Cyclical divergences (reflected in output gaps and fiscal stance) and external factors, such as relative changes in the trade-weighted nominal exchange rate or different degrees of oil intensity, may also induce

1 Usually, tradable sectors have higher productivity growth than non-tradable sectors. The resulting higher wage growth in tradable sectors pushes up wages and prices in non-tradables, thus increasing the relative prices of non-tradable goods and generating inflation.

temporary asymmetric inflationary pressures across regions. Finally, inflation differentials may be associated with non-market forces and originate from differences in wage flexibility, administered prices, indirect taxation and market power/competition.

Dynamic panel estimations for the period 1999-2006 by the ECB (Andersson et al. 2009) show that inflation differentials are primarily determined by cyclical positions and inflation persistence. The persistence in inflation differentials appears to be partly explained by administered prices and to some extent by product market regulation.

3 PHILLIPS CURVE: A DWINDLING BUT EXISTING RELATIONSHIP

A strong negative correlation between money wage rates and the unemployment rate in the United Kingdom was discovered by the economist A. Phillips in 1958. Shortly after publishing his findings, numerous studies confirmed that this relationship held in many economies. Samuelson and Solow in 1960 demonstrated the existence of the Phillips curve in the US economy.

Economists usually study the inverse relationship, that between unemployment and inflation. The assumed trade-off is low unemployment at the cost of higher inflation, or low inflation at the cost of higher unemployment. This trade-off implies that nominal variables can affect the real economy and therefore contradicts the dichotomy of the monetary theory. The Phillips curve thus became an indispensable part of Keynesian economics. In the 1970s the Phillips curve broke down, and the correlation in fact became positive, with the literature seeking for explanations.

Robert Lucas Jr. (1972), incorporating the idea of rational expectations, an idea actually proposed by John Muth's paper in 1961, extended the Friedman-Phelps theory of the long-term vertical Phillips curve. A vertical Phillips curve implies that expansionary monetary policy will increase inflation, without boosting the economy.

Economists since then have generally agreed that, under rational expectations and long-run neutrality of money, the Phillips curve is flat in the long run in the absence of supply shocks. But when prices are sticky, monetary policies are endogenous responses to output gaps and inflation.

Time periods seem to matter. Different data periods give different conclusions about the Phillips curve. Rea (1984) for instance compared the explanatory power of alternative theories on the relationship between inflation and unemployment using data for a longer period and found that no single model alone can explain this relationship. A model with a negative-sloping Phillips curve can better describe the period 1895-1956, but a monetarist model is superior for the 1957-79 period.

After the oil shock of 2008 and the global financial crisis (GFC) that followed, central banks in advanced economies failed to raise inflation close to their target levels, despite the highly accommodative monetary policies that they pursued by implementing standard (interest rate policy) and non-standard (quantitative easing) measures. Business cycle fluctuations seem to drive increasingly less inflation movements. In the United States for instance, while for four consecutive years (2016-19) unemployment had fallen below 5%, inflation never reached above 2.4%.

A consensus has not been achieved yet regarding why inflation and the unemployment rate were disconnected over the last two decades in larger economies, and different studies try to disentangle competing explanations. This apparent disconnect between inflation and real activity over the business cycle can be grouped into four main classes: (i) mismeasurement of either inflation or economic slack; (ii) a flatter wage Phillips curve; (iii) a flatter price Phillips curve; and (iv) a flatter aggregate demand rela-

tionship, induced by stronger responses of monetary policy to stabilise inflation.

Del Negro et al. (2020), using VARs and an estimated DSGE model, found that this disconnect is due primarily to the muted reaction of inflation to cost pressures, regardless of how they are measured, suggesting that the slope of the Phillips curve, i.e. the aggregate supply curve, must have fallen in the post-1990 period. The evidence that policy might have contributed to inflation stabilisation by flattening the aggregate demand curve is weaker.

In the euro area, from 2013 up to the launch of the ECB's monetary policy strategy review in January 2020, inflation was low and systematically overpredicted due to a combination of interconnected reasons. Cyclical developments account for a substantial share of the fall in underlying inflation. Additionally, there is evidence that an underestimation of the amount of economic slack and less well-anchored longer-term inflation expectations, in combination with monetary policy in the euro area being constrained by the effective lower bound, have played an important role in the long period of subdued inflation. Ongoing disinflationary structural trends (such as globalisation, digitalisation and demographic factors) are likely to have had a dampening effect on inflation over the past few decades, but were in themselves not the main drivers of low inflation in the euro area from 2013 to 2019 (Koester et al. 2021).

Eser et al. (2020), explaining the role of the structural Phillips curve in the formulation of the ECB's monetary policy, explore the role of firm profits in the pass-through from wages to prices and the contribution of external factors. They found evidence supporting the view that the absorption of slack and a firm anchoring of inflation expectations remain central to successful inflation stabilisation.

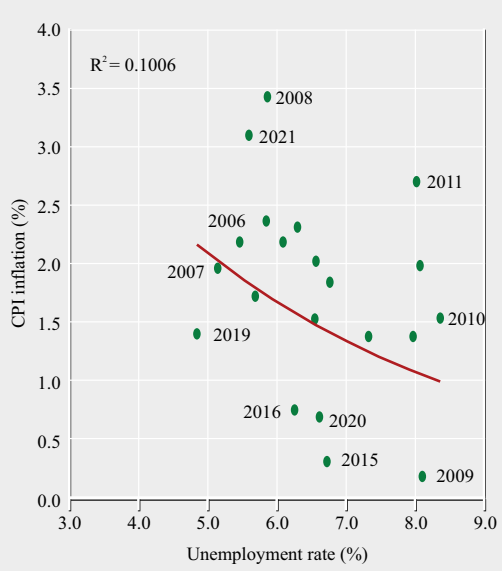
A significantly negative correlation between wages and the slack variable is also found by a recent ECB working paper (Dovì et al. 2021) estimating a standard backward-looking Phillips curve with Kinky Least Squares, but only employing supply-shock proxies that should not be omitted from Phillips curves.

Stock and Watson (2020) showed that the relationship between a cyclically sensitive inflation measure and an activity measure rather than a gap measure has been stable in the past half-century in the United States, a sharp contrast with the dramatic flattening of a simple Phillips curve suggested by other measures of inflation.

Reinbold and Wen (2020), looking at the US economy and using spectral phase analysis, confirm the importance of the time horizon. They find that in the very short run, there is no systemic relationship between inflation and unemployment, but in the intermediate run, which includes the business cycle frequency, these are strongly negatively correlated. In the very long run, the Phillips curve is strongly positively sloped. They also showed that despite the existence of the Phillips curve at the business cycle frequency under a demand shock, the monetary policy implications are not obvious, due to the unclear lead-lag relationship between inflation and unemployment.

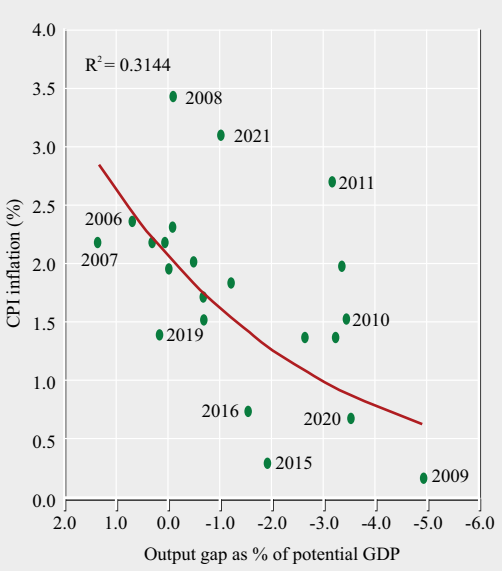
On the other hand, Lian and Freitag (2022) in their recent work agree that inflation and the unemployment rate were largely disconnected in the 2000s in many advanced economies (AEs). The slope of the simple Phillips curve was close to zero between 2000 and 2019 in the United States and the same holds for AEs as a whole. For the subperiod 2011-19 there was almost no improvement in either headline inflation or core inflation for an average AE, despite a steady decline in the unemployment rate of around 3 percentage points, a pattern that the literature refers to as "missing reflation". They also find that (i) the non-cyclical part of inflation followed a downward trend between 2012 and 2019, which existed across countries, sectors, goods and services; (ii) global indices such as oil price, shipping costs and a global supply chain pressure index do not explain this downward trend in the non-cycli-

Chart 1 Advanced economies: unemployment rate and CPI inflation, annual (2001-2022)



Source: IMF, World Economic Outlook Database, April 2022.

Chart 2 Advanced economies: output gap and CPI inflation, annual (2001-2022)



Source: IMF, World Economic Outlook Database, April 2022.

cal component of inflation; and (iii) the cyclical part, after controlling for the impact of economic slack, was also on a downward trend between 2012 and 2019.

A recent estimation of the Phillips curve for the Greek economy over the period 1991-2021 gave plausible results, notably a negative slope between -0.4 and -0.2 (Bank of Greece 2021c).

Summing up, the dwindling relationship between economic activity and inflation during the past 2-3 decades has been explored in the literature. Despite its weakening, there is evidence that the Phillips curve still survives, but its slope has flattened over time. A number of reasons have been put forward to explain the flatter Phillips curve, such as global value chains and offshoring to low-cost economies, digitalisation, the more firmly anchored long-term inflationary expectations (Hazell et al. 2020), the role of firms' profits (Eser et al. 2020), etc. Despite these efforts, the question of what structural forces underlie the reduced sensitivity of inflation to cost pressures seems to remain unanswered.

At the global level, an interesting feature is that while from a time-series perspective the relationship between inflation and unemployment appears to be weak, from a cross-sectional perspective the correlation increases. Using IMF WEO data, we explore a possible relationship between inflation and the business cycle across advanced economies over the entire 2001-21 period. The scatter diagrams in Charts 1 and 2 show a relationship which becomes clearer using the output gap as a percentage of potential GDP (see Chart 2) instead of the unemployment rate (see Chart 1). Data for selected years, such as 2008 or 2021, appear as outliers, which implies that other non-cyclical factors were behind the rise in inflation at those times. Both these years are indeed marked by steep surges in energy prices. It is also worth noting that, as shown in these scatter diagrams, the relationship of business cycle and inflation during the period 2009-11, as well as from 2020 to 2021 reveals an almost vertical Phillips curve. Alternatively, it reveals a Phillips curve that shifts constantly amid other effects and "omitted" variables.

4 PAST INFLATIONARY EPISODES, KEY TRENDS AND RECENT DEVELOPMENTS

In the post-war period, two global economic shocks during 1973-74 delivered the first strong inflationary episode worldwide, which lasted, combined with the second episode in 1979, until the early 1980s:

(i) the dissolution of the Bretton Woods system of fixed exchange rates in March 1973, following the overvaluation of the US dollar since the end of the 1960s and the US announcement of the suspension of the dollar's convertibility into gold in 1971; and

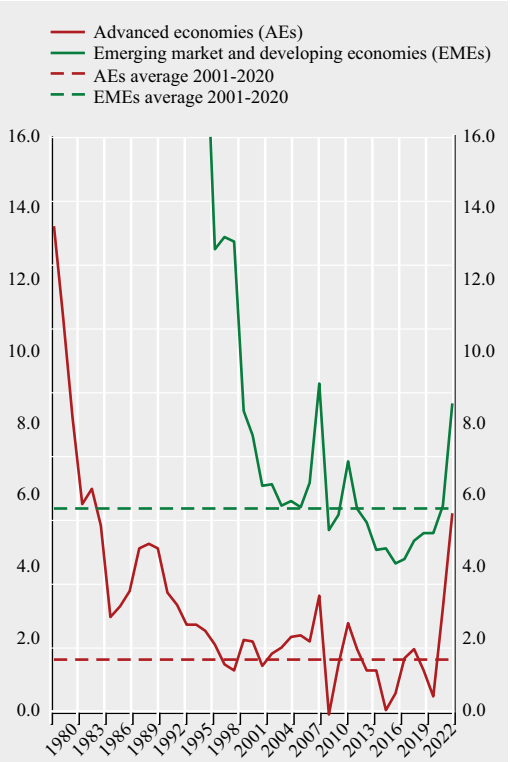
(ii) the first oil shock that began in October 1973 when the OPEC members proclaimed an oil embargo against the countries that had supported Israel during the Yom Kippur War. By the end of the embargo in March 1974, world oil prices had risen by nearly 380%, from USD 2.7 to USD 13 per barrel.

The transition to floating exchange rates for major currencies made it easier for economies to adjust to more expensive oil, facilitating adjustments to external shocks ever since, but at the expense of significantly higher inflation. Despite the two oil shocks in 1973 and 1979, by the mid-1980s high inflation had been defeated in advanced economies (AEs). Stabilisation policies followed by governments and monetary authorities contributed to that, long before China's entry into the WTO and the globalisation effect on price levels. The emerging market and developing economies (EMEs) as a whole, facing additional crises and challenges and recording a peak inflation of 114% in 1993, managed to control CPI inflation much later, only after 2000 (see Chart 3).

World oil prices were continuously rising again during the period 2002-08, from USD 25 to USD 97 per barrel (in July 2008, average world prices peaked at USD 133 per barrel before collapsing thereafter) just before the outbreak of the global financial crisis (GFC), spurring a new inflationary episode globally (see Chart 3) and contributing to a recession in AEs in 2009. Inflation peaked in 2008 at 3.8% in the United States, 3.6% in the UK, 3.3% in the euro area and just 1.4% in Japan.

Chart 3 Global headline CPI inflation (1980-2022)

(annual average %)



Source: IMF, World Economic Outlook Database, April 2022.
Notes: For 2022 estimates. Inflation in EMEs exceeded 15% until 1996, peaking at 114% in 1993.

Over the last 20 years (2001-20) average CPI inflation was similar in the United States (2.1%) and in the UK (2.0%), but in the euro-zone, which faced another recession during its sovereign debt crisis (2012 and 2013) on top of the other common recessions for AEs (in 2009 and in 2020), inflation was lower, 1.6% on average. Japan makes an exception among AEs, as inflationary pressures are muted for almost three decades, as well as GDP growth, in spite of the colossal expansionary efforts by the government and the Bank of Japan. From 2001 to 2020, the infla-

tion rate in Japan averaged just 0.1% and GDP growth a mere 0.5%.

During these 20 years, the risk of deflation came up more often than the risk of inflation. The low inflation environment gave major central banks the unprecedented opportunity to place more weight on supporting economic activity. Especially after the GFC challenge, they found themselves free to test and use unconventional tools, which would have been unthinkable in previous decades (Carstens 2022).

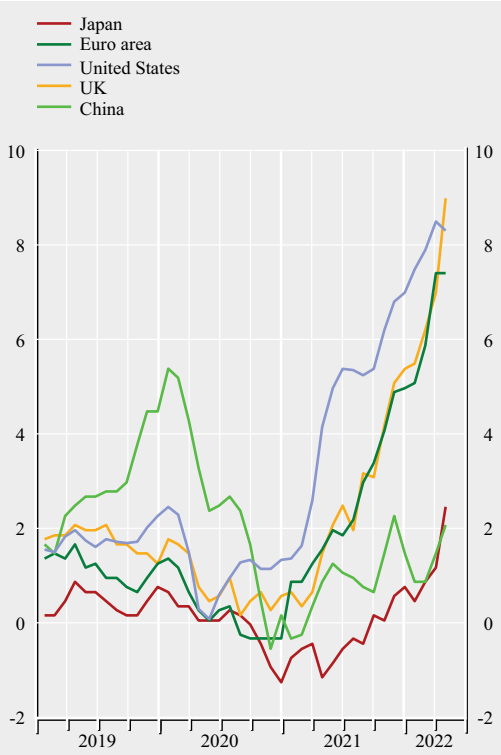
During the COVID-19 pandemic-induced recession of 2020, GDP in AEs fell by an all-time record of 4.5% (in 2009 it had shrunk by 3.3%) and inflation eased to 0.7%, the second lowest rate ever compared with 0.2% in 2009. Fears of negative inflation started to spread. Monetary policy, capitalising on the previous GFC experience, reacted more promptly, extensively and in a coordinated manner to alleviate any recessionary impact on activity and to avoid a deflationary trap.

But when economies reopened, long-forgotten inflation returned! Until the summer of 2021 the problem of rapidly rising inflation was thought to be important mainly in the United States and the UK. But by the end of 2021 it had become a problem for the global economy. Inflation rose almost everywhere in 2021. The rise was more pronounced in AEs and average annual inflation came to 3.1% in 2021, up from 0.7% in 2020. Conversely, in EMEs, inflation, which over the last two decades was triple that in AEs not even having declined in 2020 as it had in AEs, increased less (5.9%, from 5.2% in 2019 and 2020).

By December 2021, 44% of AEs (15 out of 34) witnessed a 12-month inflation running above 5% (i.e. 300 basis points above the usual target). The EMEs have been hit in a similar way, with 71% of them (78 out of 109) facing annual inflation rates above 5%. Such a sudden, shared jump in inflation (by modern standards) has not been seen since 2008, a year when

Chart 4 Headline consumer price inflation (January 2019 - April 2022)

(annual % changes)



Sources: OECD.Stat, Eurostat and ONS (UK).
Note: HICP for the euro area.

world oil prices peaked at historic highs. Inflation has thus become a global problem – or nearly so, with Asia so far immune.

The outbreak of the Russia-Ukraine war in February 2022, the threat of imposing sanctions against Russia and then the sanctions themselves have amplified further the compounding inflationary pressures amid soaring energy and food prices. By March 2022, the annual inflation rate had increased to levels not seen in decades: in the United States to 8.5%, the highest since 1981; in the UK to 7.0%, the highest since 1992; and in the euro area to a new record high of 7.4% from 5.9% in February. In Japan and China, inflation rose in March 2022, but due to weaker domestic demand and new COVID-19-related restrictions, respectively, inflation hovers at relatively lower levels than in other large economies (see Chart 4).

Among euro area countries, in March 2022, the three Baltic States had the highest annual headline inflation (between 15.6% and 11.5%), followed by the Netherlands (11.7%). In Greece, inflation rose for the tenth consecutive month to 8.0%, just above the euro area average of 7.4%. It was Greece's highest reading since July 1996. Malta and France had the lowest rates in March 2022, namely 4.5% and 5.1%, respectively.

The annual forecasts by the IMF in April 2022 gave high inflation figures for 2022 last seen in 2000 for EMEs and in 1984 for AEs (see Chart 3).

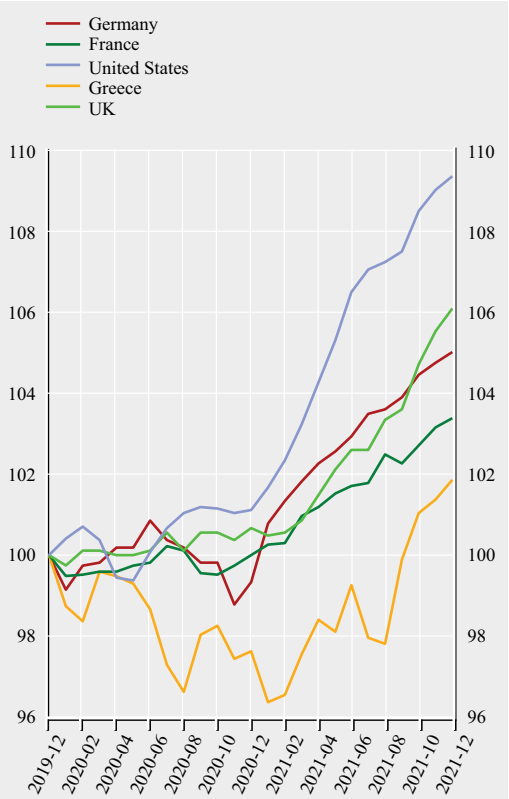
5 THE BASE EFFECT ARGUMENT

Some argue that the observed global inflation in 2021 was just an inverse of the deflation observed in the pandemic year 2020. Are the high and rising inflation rates of 2021 the result of statistical base effects, i.e. the simple gradual return of the general price level from the low levels of 2020 back to where it was before?

Assessing the inflation surge for the euro area in the course of 2021, the collapse in oil prices in the second quarter of 2020 is indeed an important factor. Base effects were more obvious in the energy inflation component. Base effects contributed cumulatively at least around 10 percentage points from April 2021 and for most of the year (Rubene and Koester 2021). Around half the energy inflation in the last quarter of 2021 can be attributed to the low 2020 level (ECB 2022). But for food prices the base effect worked in the opposite direction, as after the pandemic lockdown-related spike in spring 2020, food price developments were relatively moderate in the first half of 2021. Base effects also stemmed from changes in indirect taxes in response to the crisis, especially the temporary cut in the VAT rate implemented in Germany in the second half of 2020. Overall, in the euro area, while base effect dynamics played a larger role in the course of the year in some components of headline HICP, when combined, the effects on annual inflation rates from the low base in 2020 explain only 2 percentage points of the total 5.3 percentage point increase in the headline HICP inflation rate in December 2021 compared with December 2020 (ECB 2022).

Chart 5 CPI and HICP (December 2019 - December 2021)

(monthly data, Dec. 2019=100)



Sources: Eurostat and ONS.

When assessing inflation dynamics for each country, we get a rather different picture. We examine four key economies and Greece. We plot monthly consumer price indices for 2020-21 rebased to December 2019. Apparently, the base effect argument for inflation in 2021 is weak. Inflation in the United States, as well as in the UK and the two largest euro area economies has been higher for most of 2021 than what it would have been just due to base effects. The US CPI, the UK CPI and the harmonised indices of consumer prices (HICPs) of Germany and France

had exceeded their respective pre-pandemic levels already since January 2021.

Greek HICP inflation exhibited strong base effects throughout 2021, as it registered sharper declines than inflation in other countries during 2020, hitting its lowest level in January 2021. Following its sharper past declines, Greek HICP inflation reached its December 2019 level only in September 2021 (see Chart 5).

6 COST-PUSH OR DEMAND-PULL INFLATION?

It is important to stress that the patterns of supply/demand mismatches seen during the pandemic have been extremely rare in history. While the combination of a sudden demand shortfall and an overhang of excess supply has been observed in past financial crisis episodes, the reverse is rarely seen (Lane 2022). The recession was the unique result of state intervention in the form of forced shutdowns and lockdowns of economic activity to limit social contact and the spread of the COVID-19 pandemic.

When restrictions and lockdowns for consumers and businesses started in March 2020 to contain the pandemic, economic activity collapsed. That was a government-induced shock that hit both aggregate demand (AD) and aggregate supply (AS), especially in "high-contact" services due to social distancing measures. In the familiar AD-AS framework both curves shifted to the left. The price level thus declined to point B (see Chart 6A).

With the gradual reopening of economies from spring 2021 onwards, demand for goods and services recovered vigorously (V-shaped recovery), as expected, supported by:

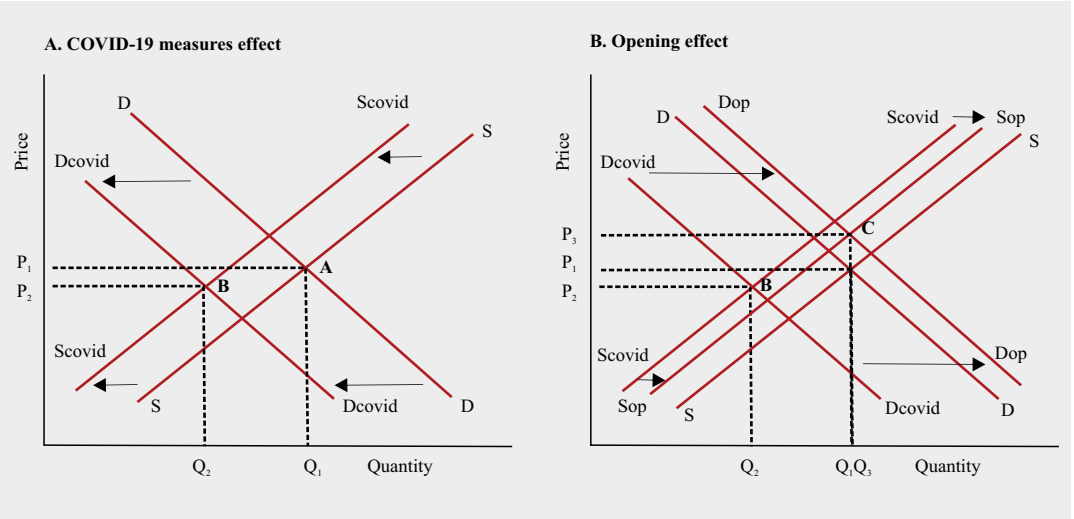
(a) previous year's pent-up demand and higher private sector savings;

(b) the ongoing favourable financial conditions provided by the zero or negative real interest rates and non-conventional extra loose monetary policy;

(c) the unprecedented, timely, substantial and synchronised fiscal support by governments; and

(d) the start of COVID-19 vaccinations, earlier on and faster in the United States and the UK and subsequently in the other countries.

Chart 6 Aggregate supply and demand



Aggregate (domestic and external) demand rose markedly during the year, but disruptions in global supply chains, brought forth by the pandemic- and lockdown-related legacy, prevented aggregate supply from adjusting in a timely manner to increased demand, thereby contributing to conditions corresponding to excess demand, creating inflationary pressures. At the same time, pandemic-inherited problems, like raw material and labour shortages as well as suppliers' longer delivery times, which were observed around the globe, compounded by soaring energy costs internationally, translated into higher production, shipping and delivery costs that were partly passed over to consumers, generating cost-push inflationary pressures. The aggregate demand curve shifted markedly to the right, while aggregate supply shifted also in the same direction but less, due to the aforementioned frictions. An average economy would end up from the COVID-19 equilibrium B to the new Opening equilibrium C, having both higher output and higher prices, P_3 (see Chart 6B).

Looking in more depth at aggregate demand, and following the theoretical analysis in Sections 2 and 3 on the Phillips curve, we must look into some measures of slack in the economy. We examine the usual suspect, the output gap, measured as the difference between actual and potential GDP (output), acknowledging the reasonable difficulties and shortcomings in calculating potential output during the unique conditions of the pandemic.

The US economy, boosted by unprecedented policy support and having a strong labour market recovery, was the only one among large AEs that had already witnessed higher real GDP than potential output in 2021. On the contrary, Japan's economy, entrapped in low inflation and low growth for almost three decades, despite colossal monetary and fiscal stimulus efforts, and having now less policy space left, witnessed almost unchanged slack in 2020 and 2021. The slack in the euro area economy on average almost halved in 2021, but remained large. According to April 2022 forecasts (IMF 2022), output gaps will persist in 2022 in the euro area and Japan, despite the pick-up in economic activity. Actual GDP in the United States and the UK for 2022 is estimated to grow faster than potential GDP (see Table 1).

Table 1 Output gap relative to potential GDP

(% deviation)

	2018	2019	2020	2021	2022*
Advanced economies	0.0	0.2	-3.5	-1.0	0.2
United States	0.0	0.7	-3.3	0.3	1.6
United Kingdom	0.3	0.6	-3.5	-0.1	0.4
Japan	-0.7	-1.4	-2.7	-2.6	-1.7
Euro area	-0.1	0.1	-4.3	-2.4	-1.0
Germany	0.8	0.4	-2.6	-2.1	-1.1
France	-0.8	0.0	-4.8	-1.8	-0.5
Greece	-5.8	-3.1	-10.7	-3.9	-1.6

Source: IMF, World Economic Outlook Database, April 2022.
* Estimates.

Different inflation developments seem to be much reflected in different developments in output gaps. During 2021 however, no economy could be characterised as overheated, and annual inflation rates seen already since the second half of 2021 obviously cannot be explained only by the degree of capacity utilisation in the economies.

Overall, output gap in AEs is estimated to have decreased significantly to -1.0% of potential GDP in 2021, from -3.5% in 2020, and is expected to turn slightly positive in 2022. Closing output gaps in AEs during 2021 and 2022 are estimated to give a positive inflation impulse of 0.23 and 0.14 percentage point each year, respectively, according to the IMF (2021).

Unemployment was on a declining trend throughout 2021 and in the first months of 2022 in almost all AEs, despite the gradual reduction of job retention schemes. In the United States, the unemployment rate had a remarkable adjustment through higher wages: from the

April 2020 peak of 14.7%, the unemployment rate came down rapidly to 6.0% in March 2021 and then further down to 3.6% in March 2022, i.e. below the pre-pandemic level of 2019 (3.7%). The unemployment rate in the UK is projected to fall to 4.0% in 2022, compared with 3.8% in the pre-COVID year 2019. Similarly, the unemployment rate in the euro area is projected to fall to 7.7% in 2022, whereas it stood at 7.6% in 2019.

Increased wage cost is traditionally associated with higher inflationary pressures, stemming from both the supply and the demand side. Depending on the market structure, mark-ups and the market power of a firm or an industry to set prices (price taker or price leader), part of the increased wages will end up in higher prices of the final product. On the other hand, increased wages boost disposable income, consumer spending and aggregate demand and, given a vertical aggregate supply curve in the short run, will result in a higher price level.

Although the world economy was on an upswing in 2021 and in spite of the significant nominal wage increases that were observed in some economies and sectors and which were to be expected after two years of stagnant or even declining wages, on annual average terms, unit labour costs, i.e. nominal wage costs deflated by labour productivity, inflated only in the United States (see Table 2).

The United States stands as an exception, given that compensation per employee had been running fast already since the second half of 2020 despite the elevated unemployment rate, as US firms tried to dissuade workers from quitting their jobs, a phenomenon called "the Great Resignation". Looking forward however, in and outside the United States, surging prices in 2022 due to the war in Ukraine, along with an increase in inflation expectations, are expected to intensify claims for nominal wage increases, thereby leading to higher unit labour costs also in the euro area and the UK, adding further to inflationary pressures.

Table 2 Unit labour costs – whole economy

(annual percentage changes)

	2018	2019	2020	2021	2022*
United States	1.9	1.9	4.1	3.2	5.9
Japan	2.6	2.0	3.4	-1.4	-0.7
United Kingdom	2.1	3.6	12.1	-2.7	2.0
Euro area	2.0	1.9	4.4	0.0	2.3
Germany	3.2	3.2	4.3	0.5	2.6
Greece	-1.0	-0.3	7.8	-5.9	1.2

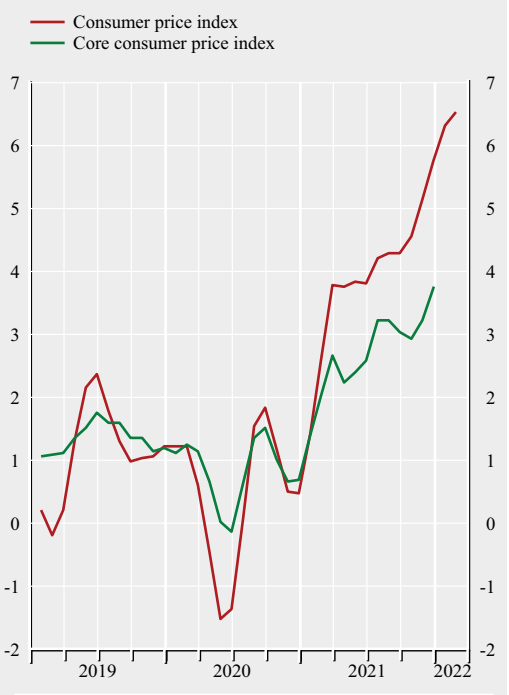
Source: European Commission, *European Economic Forecast*, Spring 2022.
* Estimates.

An analysis by an ECB Executive Board member in February 2022 concludes that the euro area is not experiencing the same degree of labour market tightness as the United States (Lane 2022). In the euro area, compensation of employees per head accelerated to 4.0% in 2021 from 0.7% in 2020, but unit labour costs (ULC) in the whole economy remained unchanged as labour productivity increased at around the same rate. According to the same set of projections (European Commission 2022), in Greece compensation per employee increased by 1.4% in 2021 against -0.7% in 2020, but ULC in the total economy declined significantly as labour productivity increased by 7.8% in 2021.

It should be noted that changes in ULC in 2020-21 were largely determined by pandemic-induced changes in labour productivity rather than by changes in nominal wages. Developments in ULC, i.e. compensation per employee divided by average labour productivity, were distorted in 2020 and 2021, as they were heavily dependent on the imposition and subsequent lifting of restrictions on economic activity and the states' job retention schemes to protect employment. Given the fall in output and the generally unaltered compensation per employee, labour productivity fell sharply in 2020 and then surged in 2021, without actually any change in wages or the underlying macroeconomic fundamentals of productivity.

Chart 7 Inflation in advanced economies: headline and core (January 2019 - February 2022)

(annual % changes, 3-month moving average)



Source: IMF, *World Economic Outlook,* April 2022.

Against this background, zero or negative ULC in 2021 are to a large extent due to the pandemic shock and they must be assessed with great caution.

Looking forward, fast-rising prices due to the war in Ukraine, along with an increase in inflation expectations, would intensify claims for nominal wage increases, adding to inflationary pressures. Estimates for 2022 in spring 2022 were pointing to a more synchronised increase in ULC in all countries and areas except for Japan (see Table 2). An ECB estimate of compensation per employee growth, which corrects for the impact of job retention schemes, shows a gradual increase in wage dynamics in the euro area up to 2023 (ECB staff macroeconomic projections, March 2022). This is consistent with the expected gradual further tightness in labour markets over the projection horizon and possible second-round effects from high inflation on wages.

Another way to examine aggregate demand-pull inflation is to look into underlying or "core" inflation, i.e. headline consumer inflation less the volatile components of energy and food.

Since the beginning of 2021 inflation in AEs has been rising almost continuously. Core inflation was rising but with a slower pace, implying that the energy and food components were increasingly contributing to overall inflation in the course of 2021 (see Chart 7). High rates and the upward trend of core inflation, even before the war in Ukraine, explains and justifies the gradual policy shift away from the ultra-loose monetary policy stance towards normalisation.

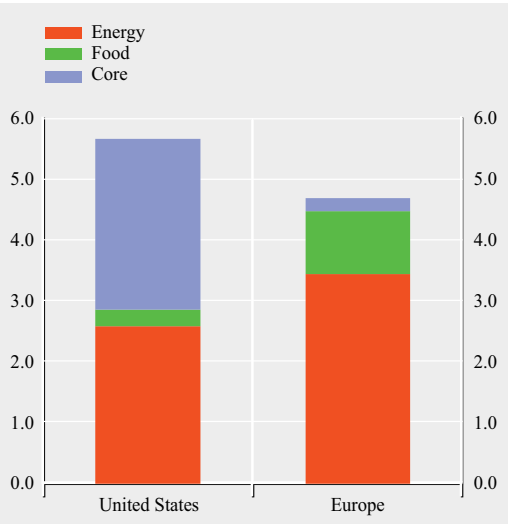
Energy and food prices were major contributing factors to headline inflation in 2021, but to varying degrees across regions. From December 2020 to December 2021, core inflation (mainly prices of industrial goods and services) was equally important as energy and food inflation for the United States, but was rather negligible for Europe. On the other hand, food and energy inflation was less important in the United States as the country is less energy and food dependent (see Chart 8).

Different core inflation developments are well explained by consumption dynamics. While consumption was approaching pre-pandemic levels in the euro area during 2022, in the United States it had recovered by spring 2021. Furthermore, the impact of the pandemic on core inflation can be split into two categories: (i) those goods and services affected mainly by supply disruptions and bottlenecks; and (ii) those goods and services affected (primarily high-contact services) mainly by reopening disruptions. The bottlenecks category has put upward pressure on core inflation in both the euro area and the United States, but the quantitative impact has been substantially larger for the United States (Lane 2022).

This different contribution of core inflation to overall inflation in the United States and the

Chart 8 Change in inflation components (December 2020 - December 2021)

(percentage points)



Source: Bank of Greece estimates.

euro area, i.e. the difference in activity cycles, explains a good part of the different pace of normalisation between the ECB and the US Federal Reserve.

7 THE ROLE OF ENERGY AND SHIPPING COSTS

After the lifting of pandemic-related restrictions on economic activity, commodity prices rose sharply, pushing upwards import prices and headline inflation. Supply-side bottlenecks also added to inflationary pressures throughout 2021. Disruptions in global value chains (GVCs) were prominent during the past two years, especially in seaborne trade and semiconductors. New coronavirus variants kept part of the labour force away from production in the beginning of 2022, delaying once again the shipping of goods and lengthening delivery times. On top of these, the war in Ukraine, the threat of imposing sanctions against Russia, the several rounds of sanctions, the efforts by countries to diverge and differentiate their energy suppliers away from Russia, all have contributed to a new round of cost-push inflationary pressures.

Energy prices, following the historic lows observed in April 2020 due to the pandemic-related collapse of world demand, started rising in the second half of 2020. By February 2021 the world energy price index compiled by the World Bank (with crude oil, natural gas and coal prices) had reached its pre-pandemic levels. From spring 2021 onwards, energy prices started to increase rapidly, amid the strong economic recovery worldwide. Without any severe energy supply-side disruptions, but with the impact of other factors, namely the geopolitical tensions and the acceleration of energy transition initiatives, energy prices kept surging throughout 2021. Against this backdrop, the European Commission (2021) in October 2021 was estimating that as global energy supply was not at risk at that time, prices should be expected to stabilise by the spring of 2022.

Non-energy commodity prices (65% of the index corresponds to agricultural commodities and 32% to metals), on an annual average basis and in real terms, surged in 2021 to their highest level observed since 1974. It was the combined result of a strong surge recorded in agricultural product prices, owing to extreme weather conditions in some food commodity producing countries, as well as in metal commodity prices, amid the global reopening of manufacturing and construction. Conversely, despite the steep increases, annual average energy prices in 2021 did not reach the all-time high levels of 2011-12, neither in nominal nor in real terms (see Chart 9).

The energy price index finally exceeded its previous highest level of 2011-12 in March and April 2022, i.e. after the outbreak of the war in Ukraine.

The average price of crude oil, after collapsing to USD 21 per barrel in April 2020, has increased almost constantly ever since, reaching USD 73 by the end of 2021. In March 2022, crude oil prices peaked at USD 112.4 per barrel after the United States announced that it was in "active discussions" to ban Russian

Chart 9 Real commodity prices (1974-2021)

(annual indices in USD, 2010=100)

Source: World Bank Commodity Price Data (The Pink Sheet).

crude oil imports, but receded to USD 103.4 in the following month. Nevertheless, the expensive crude oil, still lower than its historic high levels of 2011-12, and the appreciating US dollar heavily weighed on production costs globally, especially for energy-intensive products.

Natural gas prices saw the most prominent increase among the energy items, especially the European natural gas prices, which to a great extent hinge upon Russian exports and, as proved later on during 2022, upon Russian geopolitical and geostrategic priorities. The world average natural gas price tripled in 2021 compared with 2020, and in April 2022 it was four times the level of the pre-pandemic year 2019. The natural gas price in Europe (Netherlands Title Transfer Facility − TTF) registered the steepest increase among all commodity prices and peaked in March 2022 at USD 42.4/mmbtu, which was almost nine times the average price recorded in the pre-pandemic year 2019 (USD 4.8/mmbtu) (see Chart 10).

The effect of increases in natural gas prices on the World Bank's total energy price index may be underestimated, as according to the relevant indicator compiled, developments in natural gas prices have a low weight of only 10.8% and have been stable since 2008, compared with 84.6% for crude oil and 4.7% for coal. At the same time, the effect of oil prices on the total index may be overestimated, as the cost of renewable energy is neither calculated nor included in the World Bank's overall energy price index.[2]

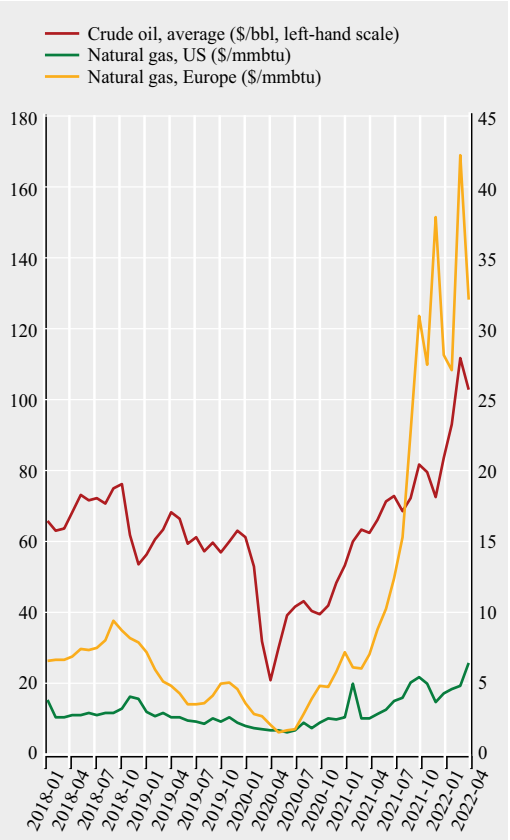
Rising gas prices in Europe in 2021 were partly the outcome of gas deliveries by Gazprom only slightly higher than pre-agreed quantities, which however were not sufficient to meet surging demand. Besides, other factors such as the increased sales of US LNG quantities to China instead of Europe and the geopolitical option of Russia pressurising Germany and the EU into certifying the Nord Stream 2 gas pipeline interplayed in the same direction.

At the EU level, natural gas accounts for 26% of total consumption. Half of this share is channelled to power generation and to the manufacturing sector, while the other half is intended for use from households. Unfortunately, the EU's energy dependency on natural gas imports stood at 90% in 2019. The hikes in natural gas prices and therefore in electricity prices differ across countries depending on the energy dependency, on the portfolio of main suppliers and their prices, as well as on the corresponding share of natural gas to total energy consumption in each country. For instance, according to Eurostat, France, having a large share of energy consumption produced domestically by nuclear reactors, together with Malta, enjoyed the lowest headline inflation rates among euro area countries in the first four months of 2022.

2 See a compilation of indices at https://www.worldbank.org/en/research/commodity-markets.

Chart 10 Oil and natural gas prices (January 2018 - April 2022)

(nominal prices in USD, monthly data)



Source: World Bank Commodity Price Data (The Pink Sheet).

With the war in Ukraine and the sanctions imposed against Russia, new inflationary pressures emerged as demand for oil and agricultural commodities surged further. The rate of increase in energy prices over the past two years has been the highest since the 1973 oil crisis. With the war, price increases for food commodities –of which Russia and Ukraine are large producers– and fertilisers, which rely on natural gas as a production input, have been the most sizeable since 2008.

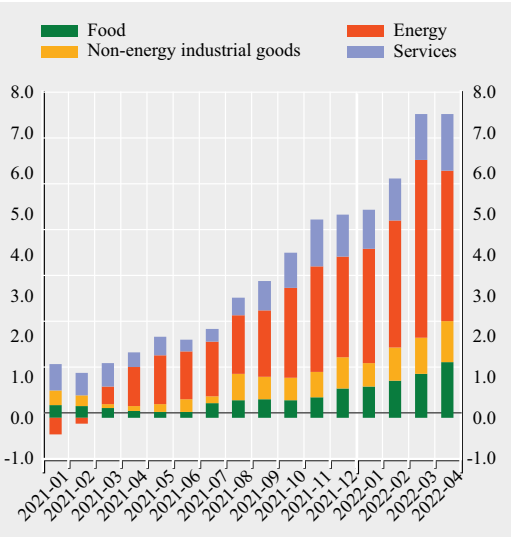
These new price increases, aggravated by a surge in restrictions on trade of food, fuel and fertilisers in some countries, have a direct impact on inflation, but have also started to have a second-round effect on the prices of industrial goods and services.

In the euro area, energy, having just a 10.9% weight on overall HICP, became the most important component of headline inflation from April 2021 onwards. In April 2022, it contributed 3.7 percentage points to the overall index, i.e. 50%. The component of food, alcohol and tobacco, having a 20.9% weight in overall HICP, became an important contributor in 2022, adding 1.35 percentage point to headline inflation in April 2022 (see Chart 11).

The World Bank (2022) warned that the war in Ukraine has dealt a major shock to commodity markets, altering global patterns of trade, production and consumption in ways that will keep prices at historically high levels through the end of 2024. According to the World Bank estimates, energy prices are expected to rise by more than 50% in 2022 before easing in 2023 and 2024. Non-energy commodity prices, including agricultural products and metals, are projected to increase by almost 20% in 2022 and will also moderate in the following years. Nevertheless, commodity prices are expected to remain well above the most recent 5-year average. In the event of a prolonged war, or additional sanctions against Russia, prices

Chart 11 Euro area HICP inflation: main components (January 2021 - April 2022)

(percentage points, annual changes)



Source: Eurostat.

could be even higher and more volatile than currently projected.

Transport costs have also soared during this entire period, as a result of supply failing to meet the abrupt surge in demand. Containerised freight rates have risen (in September 2021 they had already doubled or even tripled, compared with one year earlier), ships' average arrival time and average container unloading time at destinations have doubled, and container rental costs have increased by 3-4 times, due to lack of availability as port closures in 2020-21 led to unusually high container dislocation.

Bottlenecks in global supply chains of goods stem from the interplay of several factors. First, the strong rebound in global demand for manufacturing goods, shifting away from services in the context of the social distancing measures, was not matched by an equal increase in the supply of goods. Second, the abrupt surge in demand for electronic products and equipment, as teleworking became the new normality in several sectors, resulted in severe supply shortages of semiconductors, which are important for other sectors such as the automotive industry, which was particularly hit. According to a recent ECB study, detailed data presented in heatmaps suggest that, in general, supply bottlenecks in the euro area and the United States over the first months of 2022 remained at historically high levels, although pressures may be easing in some sectors (Attinasi et al. 2022)

The impact of higher commodity prices and shipping costs on import and domestic prices explains, according to the OECD, around 75% of the pick-up in inflation for 2021 in G20 countries, corresponding to around 1.5 percentage point (OECD 2021).

8 LESSONS AND POLICY IMPLICATIONS

After the two oil shocks in the 1970s, inflation surged globally. US monetary policy was initially hesitant and legally unable to use interest rates effectively. The 1978 Humphrey-Hawkins Act amended the Federal Reserve's mandate and enabled the then Federal Reserve Board Chair Paul Volcker to aggressively raise interest rates. The federal funds rate, which averaged 11.2% in 1979, was raised to 20% in June 1981. A demand-led recession pulled down inflation, which had peaked at almost 15% in March 1980, to 6.2% in 1982 and 3.2% in 1983. The main policy lessons learnt from the US Great Inflation of the 1970s were the importance of an independent central bank as a potential mitigating factor to inflationary bias, the prudent medium-term fiscal planning, and the adherence to stabilising monetary rules and inflation targeting (IMF 2021).

For several decades now, high or persistent inflation has hardly been a concern for the major central banks of AEs. On the contrary, after the GFC in 2008-09, the prime challenge had been to bring inflation up to target. During the last 20 years, policymakers in AEs worried more about the risk of deflation or negative inflation rather than inflation. The environment of low inflation and nearly zero policy rates gave to major central banks the unprecedented opportunity to place more weight on other objectives, such as supporting ailing demand or reducing financing costs for the private and the public sector. Especially after the GFC challenge, they found themselves free to test and use unconventional monetary policy tools unthinkable in previous decades. With regard to the Eurosystem in particular, the "bazooka" measures taken in the context of the GFC and the euro area sovereign debt crisis were targeting the impaired monetary policy transmission mechanism and never stopped aiming at the primary objective of safeguarding financial and price stability.

After a long period of ultra-loose monetary policy, central banks may now need to reassess how they respond to inflation resulting from the supply side. Critical for that assessment is always the distinction between temporary or

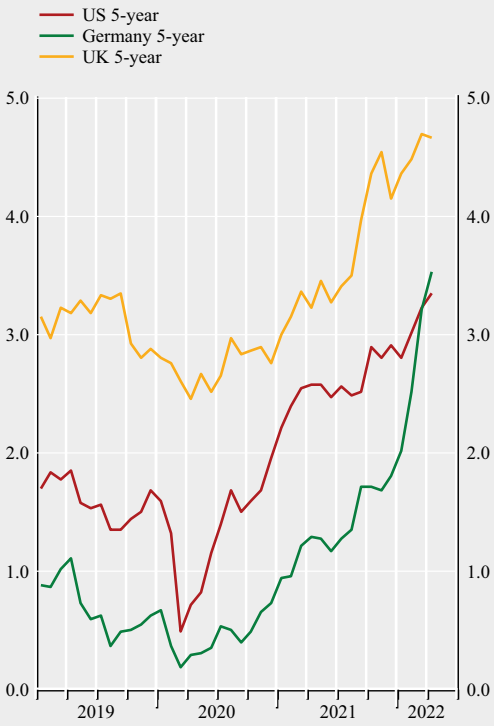
more persistent inflationary pressures. But recent experience now suggests that it can be difficult to make such a clear-cut distinction.

Inflation expectations are important for central banks to monitor. The continuous rise in inflation has led indicators of expected inflation to rise above pre-pandemic levels in the United States and Germany since early 2021. Market expectations, as implied by breakeven inflation rates, i.e. the spread between nominal and inflation-linked benchmark bonds, have moved higher both in the five-year and the ten-year horizon. The increase became steeper in Germany over the first months of 2022. At the end of April 2022, market expectations for the five-year horizon inflation stood at 3.3% in the United States and 3.5% in Germany, i.e. rates significantly lower than the prevailing annual headline inflation rates (see Chart 12). With the Fed leading the tightening cycle (first interest rate hike in March 2022), expectations for policy rate hikes by major central banks during 2022 accelerated in spring 2022.

Anchoring expectations emerges again as a challenge. Broad progress in the anchoring of inflation expectations during the decade before the pandemic seems to be paying dividends in the post-COVID period. Despite the sharp increases in inflation during 2021, long-term expectations are found to have remained contained in most of the economies, as we saw earlier. This should provide central banks with time and space for manoeuvre between inflation and recovery. However, in many economies, rising inflation has pulled short-term expectations higher. In a few cases, long-term expectations have also been pulled higher, albeit to a lesser degree. Central banks will have to manage expectations against an increasingly challenging economic landscape, whereby supply-side pressures on prices are likely to persist in the next several quarters, aggravated by the war and geopolitical factors. As suggested by well-behaved expectations until now, monetary authorities have retained the confidence of market participants that

Chart 12 Breakeven inflation rates (January 2019 - April 2022)

(monthly frequency, end-of-month data, yield differential between nominal and inflation-linked benchmark bonds with a maturity of 5 years)



Sources: Federal Reserve Economic Data (FRED) and Refinitiv.

inflationary impulses can be dealt with in a way consistent with central banks' mandates. However, recent findings suggest that this hard-earned confidence will need to be nurtured and strengthened (Goel and Tsatsaronis 2022).

Monetary authorities of major economies are already taking advantage of the credibility and reputation that they have earned during the past decades. The adoption of a reviewed monetary policy framework in the United States on 27 August 2020 corroborated the intention of showing tolerance for higher inflation rates with a view to boosting employment and economic growth. Likewise, the ECB in the context of the Eurosystem's monetary policy strategy review, which was concluded in July 2021, set a symmetric 2% inflation target rather than a target of close to and below 2%, which was

the previous one. In particular, when the economy is close to the lower bound, this requires especially forceful or persistent monetary policy measures to avoid negative deviations from the inflation target becoming entrenched. This may also imply a transitory period in which inflation is moderately above target. Forward guidance should continue to play a central part in shaping inflation expectations.

Policy mistakes of 1970s monetary accommodation of supply-side shocks are unwanted. The sharp increases in oil prices were then followed by several years of high inflation and low growth, the so-called "stagflation". In the present inflationary episode, the rise in the price level, as a result of surging demand in individual economies and higher commodity prices, shows strong correlation. Inflation is expected to decline gradually with the normalisation of demand and supply conditions. The easing of strong demand will be the result of decreasing real disposal income stemming either from high inflation or from the reversal of the policy stimulus and a faster normalisation of monetary policy.

Resolute action must be taken before today's inflation rate gets embedded in tomorrow's inflation expectations, potentially igniting a wage-price spiral akin to that of the 1970s and resulting in a costly recession. Action not necessarily taken only by central banks. A PIIE Policy Brief is proposing non-monetary policy action: trade liberalisation measures can meaningfully support fiscal and monetary measures. The data cited in this Policy Brief indicate that a feasible package of trade liberalisation in the United States could deliver a one-time reduction in CPI inflation of around 1.3 percentage point and possibly of 2.0 percentage points in the longer term, through lower import and domestic prices (Hufbauer et al. 2022).

Labour market tightness is not crucial for inflationary pressures in AEs for the moment. But with elevated inflation seriously affecting the cost of living and real wages, inflation could trigger a dangerous wage-price spiral in several AEs. Securing low inflation is a powerful tool to avert such a development. The role of past inflation in determining wage growth has weakened relative to the mid-1990s, but there are some signs that price spillovers to wages are increasing again.

Monetary authorities cannot ensure global growth by keeping an accommodative stance under all conditions. The behaviour of central banks does not need to be popular, but useful instead for medium-term stability and long-run growth. Central banks should be aware that short-term costs in terms of growth and employment may be the price to pay to avoid bigger costs in the future. The short-term costs to economic activity represent an investment in central banks' credibility, which yields longer-term benefits (Carstens 2022).

9 CONCLUSIONS

Inflationary pressures and inflation across the global economy have been on the rise since the beginning of 2021. Inflation increased very fast, especially in advanced economies, driven by a combination of demand- and supply-side factors. On the demand side, the strong recovery of the global economy has led to steep increases in the prices of energy and other commodities. On the supply side, disruptions in GVCs and in sea transport have led to sharp increases in input and transportation costs, which also push prices upwards. Hikes in both energy and non-energy commodity prices are driving inflation upwards. The Russian invasion of Ukraine in February 2022, apart from causing a humanitarian crisis, pushed inflation higher in many advanced economies to levels not seen after the two oil shocks in the 1970s.

The two oil shocks were the main factor behind the previous persistent inflationary episode in the 1970s and were followed by several years of stagflation. The relationship between economic activity and inflation during the past 2-3 decades has been dwindling. Despite its

weakening, there is evidence that the Phillips curve still survives but its slope has flattened over time. Inflation rates in 2021-22 have been largely a reflection of the pandemic cycle, its problematic legacy and the policy response. The unprecedented recession was followed by a strong recovery in domestic and global demand for energy and products, fuelled by pent-up demand and increased savings, as well as by a slower response of aggregate supply due to global bottlenecks and supply-side disruptions. Rapidly closing output gaps and labour market developments were the main contributors to inflation in the United States, whereas hikes in energy commodity prices, mostly soaring natural gas prices, were driving inflation upwards in the euro area. Developments in energy prices have different impact and pass-through across economies, depending on their energy dependency and the energy mix that they consume.

With the conflict in Ukraine still continuing for an unknown period of time and the sanctions on Russian energy supply, inflation is expected to remain elevated for longer than previously thought. Central banks in advanced economies initially accepted the overshooting of inflation rates, as inflationary pressures were judged to be transient, and supporting the post-pandemic recovery was the top priority. Given the return of unemployment down to pre-pandemic levels and signs of some tightness in labour markets, monetary authorities in advanced economies are and should gradually be shifting towards a more neutral stance to safeguard price stability in the medium term. The costs of a possible de-anchoring of inflation expectations to economic activity may prove far higher than the short-term costs of a tighter policy. The anchoring of inflation expectations should not be taken for granted and is certainly not a free lunch.

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PROPOSALS FOR THE REFORM OF EU FISCAL RULES

Nikos Ventouris
Bank of Greece, Economic Analysis and Research Department

Georgios Palaiodimos
Bank of Greece, Economic Analysis and Research Department

ABSTRACT

The aim of this paper is to contribute to the ongoing debate regarding the reform of the EU fiscal framework, with a special focus on fiscal sustainability for Greece. Our key policy proposals for the EU fiscal rules draw on lessons from past experience, the conclusions of relevant studies and the fiscal sustainability risks faced by Greece and other high-debt countries in the euro area. To this end, we use the European Fiscal Board's Compliance Tracker Dataset to assess compliance with the existing SGP framework. Moreover, we employ the Bank of Greece's Debt Sustainability Analysis (DSA) model to identify possible fiscal sustainability risks for Greece over the medium- to long-term horizon, taking into account alternative economic policy scenarios (including a debt rule scenario). Our main findings indicate that the revised fiscal framework should focus on the need to enhance sustainability of public debt as a key priority, by setting a debt anchor as a medium-term fiscal objective, with a single operational expenditure rule that promotes countercyclicality of fiscal policy. The current benchmark levels could be maintained and complemented with the appropriate flexibility in the rate of debt reduction to address cross-country heterogeneity and avoid self-defeating effects of fiscal policy. In the case of Greece, despite the favourable characteristics of public debt, fiscal policy in the short and medium term should focus on accelerating debt reduction. The exposure of Greece's public debt dynamics to market and interest rate risks will gradually increase, as official sector debt is replaced by market financing, thereby changing the structure of public debt and highlighting the need to create fiscal buffers in order to increase its resilience to future adverse macroeconomic shocks.

Keywords: Economic and Monetary Union (EMU); fiscal rules; debt sustainability; Stability and Growth Pact (SGP); fiscal policy

JEL classification: E62; E63; H11; H50; H6

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ΠΡΟΤΑΣΕΙΣ ΓΙΑ ΤΗΝ ΑΝΑΘΕΩΡΗΣΗ ΤΩΝ ΔΗΜΟΣΙΟΝΟΜΙΚΩΝ ΚΑΝΟΝΩΝ ΤΗΣ ΕΕ

Νίκος Βεντούρης
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

Γεώργιος Παλαιοδήμος
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

ΠΕΡΙΛΗΨΗ

Σκοπός της παρούσας μελέτης είναι να συμβάλει στη συνεχιζόμενη συζήτηση σχετικά με τη μεταρρύθμιση του δημοσιονομικού πλαισίου της ΕΕ, με ιδιαίτερη έμφαση στη δημοσιονομική βιωσιμότητα της Ελλάδος. Οι βασικές μας προτάσεις πολιτικής για τους δημοσιονομικούς κανόνες της ΕΕ βασίζονται σε διδάγματα από την εμπειρία του παρελθόντος, στα συμπεράσματα σχετικών μελετών και στους κινδύνους δημοσιονομικής βιωσιμότητας που αντιμετωπίζουν η Ελλάδα και άλλες χώρες με υψηλό χρέος στην ευρωζώνη. Για την ανάλυσή μας, χρησιμοποιούμε τη βάση δεδομένων παρακολούθησης της συμμόρφωσης με τους ευρωπαϊκούς δημοσιονομικούς κανόνες (Compliance Tracker Dataset) του Ευρωπαϊκού Δημοσιονομικού Συμβουλίου, προκειμένου να αξιολογήσουμε τη συμμόρφωση με το υφιστάμενο πλαίσιο του Συμφώνου Σταθερότητας και Ανάπτυξης. Επιπλέον, χρησιμοποιούμε το μοντέλο βιωσιμότητας δημόσιου χρέους της Τράπεζας της Ελλάδος για τον εντοπισμό πιθανών δημοσιονομικών κινδύνων για την Ελλάδα σε μεσομακροπρόθεσμο ορίζοντα, λαμβάνοντας υπόψη εναλλακτικά σενάρια οικονομικής πολιτικής (συμπεριλαμβανομένου ενός σεναρίου εφαρμογής του κανόνα χρέους). Τα κύρια ευρήματά μας δείχνουν ότι το αναθεωρημένο δημοσιονομικό πλαίσιο θα πρέπει να επικεντρωθεί στην ανάγκη ενίσχυσης της βιωσιμότητας του δημόσιου χρέους ως βασική προτεραιότητα, θέτοντας τη μείωση του χρέους ως μεσοπρόθεσμο δημοσιονομικό στόχο, με ένα λειτουργικό κανόνα δαπανών που προωθεί την αντικυκλικότητα της δημοσιονομικής πολιτικής. Τα υφιστάμενα επίπεδα αναφοράς θα μπορούσαν να διατηρηθούν και να συμπληρωθούν με την κατάλληλη ευελιξία στο ρυθμό μείωσης του χρέους, για την αντιμετώπιση της ετερογένειας μεταξύ των χωρών και την αποφυγή αυτοαναιρούμενων επιδράσεων της δημοσιονομικής πολιτικής. Στην περίπτωση της Ελλάδος, παρά τα ευνοϊκά χαρακτηριστικά του δημόσιου χρέους, η δημοσιονομική πολιτική βραχυπρόθεσμα και μεσοπρόθεσμα θα πρέπει να επικεντρωθεί στην επιτάχυνση της μείωσής του. Η έκθεση της δυναμικής του δημόσιου χρέους της Ελλάδος σε κινδύνους αγοράς και επιτοκίου θα αυξηθεί σταδιακά, καθώς το χρέος του επίσημου τομέα αντικαθίσταται από χρέος που χρηματοδοτείται με όρους αγοράς, με αποτέλεσμα να αλλάζει η δομή του δημόσιου χρέους και να εντείνεται η ανάγκη δημιουργίας δημοσιονομικών αποθεμάτων, προκειμένου να αυξηθεί η ανθεκτικότητά του σε μελλοντικές δυσμενείς μακροοικονομικές διαταραχές.

PROPOSALS FOR THE REFORM OF EU FISCAL RULES*

Nikos Ventouris
Bank of Greece, Economic Analysis and Research Department

Georgios Palaiodimos
Bank of Greece, Economic Analysis and Research Department

INTRODUCTION

The objective of fiscal rules is to introduce incentives and restrictions on discretionary fiscal policy, in order to promote policies that ensure the sustainability of public finances. The main reasons for using fiscal rules are: (1) the increase in budget deficits and public debt recorded in most advanced economies in recent decades; and (2) the tendency of economic policymakers to implement procyclical fiscal policies leading to instability and significant macroeconomic imbalances. Ideally, fiscal rules should be designed to promote in tandem fiscal discipline and macroeconomic stabilisation. Their design should also include key elements such as monitoring and compliance mechanisms, a framework of sanctions and appropriate procedures for correcting potential deviations, in order to ensure their credibility and effectiveness.

The consultation on the reform of EU fiscal rules is a process initiated before the outbreak of the pandemic. The pandemic crisis prompted a temporary suspension of the Stability and Growth Pact (SGP) rules and the activation of the General Escape Clause, leading to a sharp increase in public debt due to the expansionary fiscal policy and the increased borrowing required to finance emergency measures, coupled with a decline in economic activity. A prompt return to the strict implementation of the current European fiscal framework would require excessive fiscal consolidation, especially in countries with high debt levels, in order to avoid entering the Excessive Deficit Procedure. Therefore, following the lifting of the SGP General Escape Clause, it is necessary to adapt the current fiscal rules to the new economic conditions.

The purpose of this paper is to contribute to the ongoing debate regarding the reform of the EU fiscal framework, drawing on lessons learnt from past experience, the conclusions of relevant studies and the analysis of future economic challenges.[1] To this end, the key principles of the current SGP are presented (Section 1) and then assessed (Section 2), with particular focus on compliance with the existing fiscal rules (Section 3). The main public proposals for the reform of the SGP are summarised next (Section 4). In the longer term, there is an urgent need to strengthen public debt sustainability, and the outlook for Greece vis-à-vis other high-debt euro area countries is analysed in this respect (Section 5). In addition, a similar comparison is made as regards the implications of applying the current debt rule in these countries (Section 6). The combined results of this analysis lead to proposed guidelines for the reform of the European fiscal rules (Section 7).

1 KEY PRINCIPLES OF THE CURRENT STABILITY AND GROWTH PACT (SGP)

The SGP was introduced at the same time as the single currency, with a view to ensuring sound public finances in the euro area. However, before the financial crisis it had limited success in preventing the emergence of severe fiscal imbalances in some Member States. During the euro area debt crisis, the SGP was reformed by introducing a stricter framework of common rules through the Six Pack (2011)

* The views expressed in this article are of the authors and do not necessarily reflect those of the Bank of Greece. The authors are responsible for any errors or omissions.

1 For a similar analysis, see the special feature entitled "European fiscal rules: achievements, weaknesses and proposal for their improvement", in Bank of Greece, *Annual Report 2019*, March 2020.

and the Two Pack (2013), which brought significant changes to the fiscal framework and the way these rules were enforced.[2] These rules were further enhanced by the Fiscal Compact,[3] introduced in 2013. The current SGP includes five main restrictions and rules and a monitoring framework:

1) Two medium-term targets: budget deficit of less than 3% of GDP and debt of less than 60% of GDP.

2) Two fiscal rules relating to the "Preventive Arm" of the SGP: (i) The first is the Structural Budget Balance Rule.[4] It concerns the convergence of the structural balance towards the Medium-Term Budgetary Objective (MTO), i.e. a relatively balanced budget in structural terms, giving Member States sufficient flexibility to use the available fiscal space without exceeding the deficit threshold of 3% of GDP. For convergence towards the MTO, the structural budget balance should improve by 0.5% of GDP per year, or by the remaining distance from the MTO if this is less than 0.5% of GDP. If a country's fiscal position is above its MTO, then the structural balance cannot fall short of the MTO. (ii) The second is the Debt Rule, which was introduced to ensure convergence of debt-to-GDP ratios towards the medium-term benchmark. According to the debt rule, the debt-to-GDP ratio should decrease by 1/20 of the distance between the current debt/GDP level and the benchmark value per year, on average over a 3-year period.[5]

3) A ceiling on the increase in primary expenditure. The European expenditure rule provides that the annual growth rate of primary government expenditure must not exceed the medium-term growth rate of potential GDP in nominal terms (10-year average) minus the margin necessary for the adjustment of the structural budget balance (in line with the corresponding rule), unless the excess is combined with revenue measures. The current "expenditure limit" is not a "rule" in the sense of other budgetary constraints, but is primarily designed to indicate to government authorities what is needed in order to meet the requirements based on the MTO.[6]

4) Fiscal policies are monitored using multiple indicators, which inevitably often lead to conflicting conclusions. Compliance is therefore assessed using a critical approach, weighing the strengths and weaknesses of the various indicators.

5) A complex regulatory framework allows for Member State flexibility (depending on the cyclical fluctuations of the economy), enabling them to negotiate the size of the required fiscal adjustment.

6) An escalating system of warnings and sanctions for non-compliance. This is the "Corrective Arm" of the SGP, which sets out two procedures: (i) the Significant Deviation Procedure (SDP); and (ii) the Excessive Deficit Procedure (EDP). These procedures are triggered when a country breaches the preventive arm or the fiscal targets of the SGP, respectively, and indicate concrete actions that

2 For more details, see European Commission, EU Economic governance: monitoring, prevention, correction, and Legal basis of the Stability and Growth Pact.

3 Treaty on Stability, Coordination and Governance in the Economic and Monetary Union, TSCG. According to this Treaty, the medium-term budgetary objectives (MTOs) should be transposed into national law with a clear structural deficit limit of 0.5% of GDP (or 1% of GDP in exceptional circumstances). The MTOs are different for each country, depending on the level of debt and the estimated cost of population ageing. The Treaty also provides for automatic correction mechanisms in case the structural deficit threshold is breached. The MTOs may be revised when a major structural reform is undertaken or every 3 years, on the occasion of the publication of projections allowing for an update of the estimated population ageing costs. For Greece, the MTO is set at 0.25% of GDP.

4 In 2005, a cyclically adjusted operational indicator, the structural budget balance, was introduced into the SGP, which removes from the fiscal balance the effects of both the economic cycle and one-off measures. It is therefore a measure of the intensity of the fiscal adjustment effort. Its level is a target in the SGP's preventive arm and indicates whether there is need for fiscal adjustment.

5 In practice, the activation of the Excessive Deficit Procedure was based more on the structural budget balance rule and convergence towards the MTO, rather than on the debt rule.

6 Although the European Commission is carrying out a comprehensive assessment based on both the structural budget balance rule and the expenditure rule to determine whether or not a country complies with the SGP preventive arm, significantly less attention has so far been paid to the expenditure rule than to the structural budget balance rule. The Vade Mecum on the SGP describes the expenditure rule as a "complement to structural fiscal adjustment", suggesting a kind of implicit hierarchy between the rules within the preventive arm.

countries need to take, in order to correct their fiscal imbalances and avoid sanctions.

2 ASSESSMENT OF THE CURRENT SGP

Before the pandemic crisis, fiscal performance in the euro area as a whole showed that the reformed fiscal framework contributed to the sustainability of public finances, leading to lower deficits and improved debt dynamics. The achievement of the MTOs created fiscal buffers in most Member States. At the same time, it has been possible to identify fiscal risks early on and coordinate fiscal policies through the European Semester process, in the context of which Member States' Stability Programmes and National Reform Programmes are submitted and assessed, and the resulting recommendations are taken into account in the preparation of the Draft Budgetary Plans.

The consultation on the reform of fiscal rules in the EU is a process initiated before the pandemic, since some weaknesses of the current fiscal framework were already evident, despite the progress in strengthening economic governance.[7] These weaknesses included:

(i) The procyclicality of fiscal policy, especially in countries with high public debt.[8] Procyclicality led to limited accumulation of fiscal buffers in good times on the one hand and, on the other hand, to self-defeating effects on public debt dynamics, as the size of the recession caused by the required sharp fiscal adjustment cancelled part of the positive contribution of the budget balance, weighing on its dynamics.[9] At the same time, procyclical national fiscal policies have resulted in a number of countries marginally complying with the 3% deficit criterion, but not converging in structural terms towards the MTOs.[10]

(ii) The fact that the SGP has become a complex and confusing set of rules. Through the various revisions of the SGP, the number of monitoring rules and indicators, together with the implementation procedures and exceptions, increased significantly, making the fiscal framework complex and onerous. In addition, the national fiscal rules linked to the Fiscal Compact were found to be inconsistent.[11] Lastly, the use of non-observable variables, such as the output gap, has been accompanied by frequent revisions, complicating the comprehension and, thus, the political ownership of fiscal rules.[12]

(iii) The difficulty of practical implementation and compliance by Member States, undermining the credibility of the fiscal framework. Compliance with the fiscal framework has been largely heterogeneous across countries, periods and rules, including compliance with the MTOs, even in good times. According to the European Network of EU Independent Fiscal Institutions, the revision of some SGP rules was seen as optimistic, the main example being the debt rule. While the SGP's debt rule was initially designed as a counterbalance to the observed fiscal policy procyclicality in the euro area, ultimately it led to limited compliance by Member States with high debt, which resorted to the available flexibility as a way to avoid an EDP.[13]

7 European Commission (2020), "European governance review", Staff Working Document; Pisani-Ferry, J. (2018), "Euro area reform: An Anatomy of the debate", *VoxEU.org*; Feld, L., C. Schmidt, I. Schnabel and V. Wieland (2018), "Refocusing the European fiscal framework", *VoxEU.org*; and Blanchard, O., A. Leandro and J. Zettelmeyer (2021), "Redesigning EU fiscal rules: from rules to standards", Peterson Institute for International Economics, Working Paper 21-1.

8 European Fiscal Board (2019), *Assessment of EU fiscal rules with a focus on the six and two-pack legislation.*

9 Attinasi, M.G. and L. Metelli (2016), "Is fiscal consolidation self-defeating? A panel-VAR analysis for the euro area countries", ECB Working Paper No. 1883.

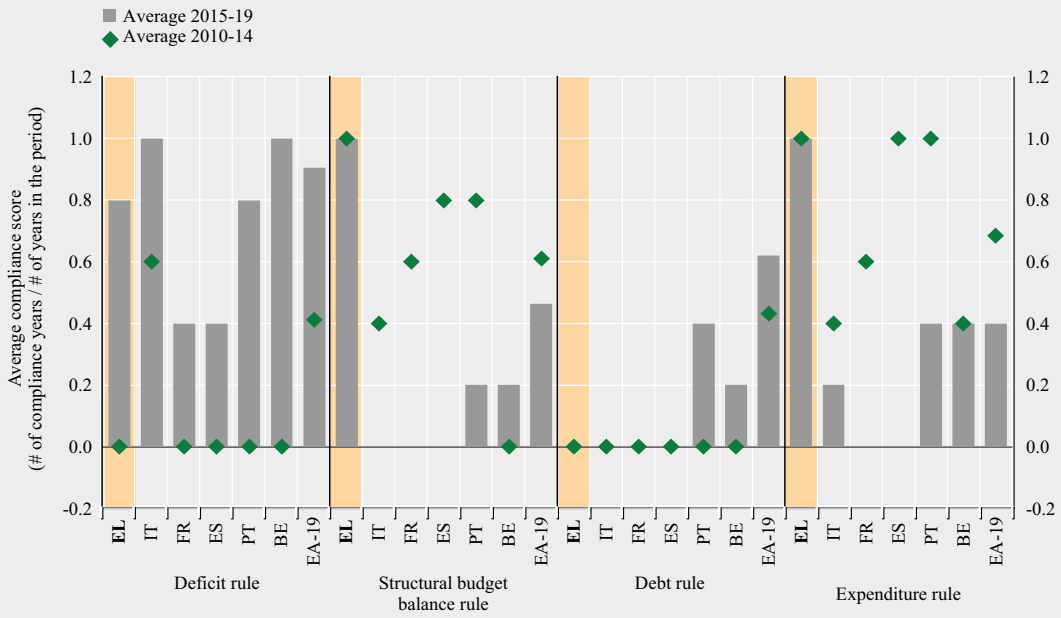
10 Mainly countries with high public debt or countries subject to an Excessive Deficit Procedure (EDP). See European Commission (2020), op. cit., footnote 7; and Caselli, F. and P. Wingender (2018), "Bunching at 3 Percent: The Maastricht Fiscal Criterion and Government Deficits", IMF Working Paper No. 18/182.

11 Deroose, S., N. Carnot, L.R. Pench and G. Mourre (2018), "EU fiscal rules: Root causes of its complexity", *VoxEU.org*.

12 European Commission (2020), op. cit., footnote 7.

13 Larch, M. and S. Santacroce (2020), "Numerical compliance with EU fiscal rules: The compliance database of the Secretariat of the European Fiscal Board"; Darvas, Z., P. Martin and X. Ragot (2018), "European fiscal rules require a major overhaul", *Policy Contribution*, No. 18; and De Jong, J. and N.D. Gilbert (2018), "Fiscal Discipline in EMU? Testing the Effectiveness of the Excessive Deficit Procedure", De Nederlandsche Bank Working Paper No. 607.

Chart 1 Compliance scores – Fiscal rules (EA-19, selected countries)



Source: EFB Compliance Tracker Dataset.

3 COMPLIANCE WITH THE CURRENT FISCAL RULES[14]

- **Deficit rule:** The assessment of the fiscal performance of EU Member States in recent years has mainly focused on the deficit rule,[15] in order to avoid sanctions and country surveillance. According to the European Commission's indicators, compliance with this fiscal rule increased significantly in 2015-19 compared with the previous period 2010-14 on average in the euro area (EA-19), with all high-debt countries improving their performance due to fiscal adjustment (see Chart 1). Among the high-debt countries, Greece recorded on average the largest annual target overperformance during the 2015-19 period (by around 2 p.p. of GDP), the second largest improvement at the EU level compared with 2010-14.

- **Structural budget balance rule:** Fiscal adjustment in most countries mainly relied on one-off measures, as compliance with the structural budget balance rule in 2015-19 remained moderate and marginally deteriorated compared with 2010-14 on average in the EA-19. Among high-debt countries with increased debt sustainability risks, Greece is an exception due to the large structural fiscal adjustment in 2010-19, fully complying with this fiscal rule (see Chart 1) and even recording the largest target overperformance (by 4 p.p. of GDP) among all EA-19 countries on average per year.

- **Debt rule:** Compliance with the deficit rule resulted in greater compliance with the debt rule at the EA-19 level, but not in most countries with high debt/GDP levels and high sustainability risks. On average, most high-debt countries (except Portugal and

14 The compliance scores for fiscal ruless (see Chart 1) are compiled by the European Fiscal Board. These are dummy variables that take the value of 1 for each year if a country is compliant with each EU fiscal rule and 0 otherwise.

15 A country is deemed to comply with the deficit rule if: (i) the general government deficit is equal to or below 3% of GDP; or (ii) the 3% of GDP threshold has been exceeded, but the deviation remains small (up to 0.5% of GDP) and is limited to a single year.

Belgium) have breached this fiscal rule, showing significant underperformance, which means that they have not managed to reduce the debt-to-GDP ratio at the required pace (see Chart 1).[16] Over time, Greece has the largest negative deviations from this rule on average per year, despite some improvement in 2015-19.

- **Expenditure rule:** The compliance score for the expenditure rule shows that, on average, compliance deteriorated in 2015-19 (compared with fiscal performance in 2010-14) for most EA-19 countries. From 2011 onwards, the balance between the EA-19 compliant and non-compliant countries with regard to this fiscal rule started to deteriorate in favour of the latter, while in 2016-19 non-compliant countries outnumbered compliant countries. Greece is one of only two EU countries that fully complied with this rule throughout the period 2010-19, while the other high-debt euro area countries saw a sharp deterioration in their compliance indicators. It is worth noting that Greece had the highest target overperfromance among EA-19 countries as a result of the strong fiscal adjustment during this period.[17]

4 MAIN PROPOSALS FOR THE REFORM OF THE SGP

In order to be more effective and resilient, the fiscal governance framework in the post-pandemic period must not only correct pre-existing failings, but also adapt to the new macroeconomic and fiscal reality. It should therefore address a number of crucial issues for the euro area, such as high public debt levels, the need to finance investment for the green and digital transformation of the economy, and the prevention of economic divergence among Member States. With the publication of the European Commission's views in the first half of 2022, many authors and researchers propose concrete changes to the SGP, aiming to reduce the number of rules and revise the debt rule, with stronger emphasis on the growth rate of primary expenditure as the main operational tool to achieve the fiscal targets.

The European Fiscal Board (EFB) (2018, 2019, 2020)[18] recommends setting country-specific debt adjustment rates towards a long-term target (debt rule). The rate of convergence towards the long-term target[19] will depend on a set of fundamental variables,[20] promoting debt reduction in good times. The EFB's proposals are also based on a ceiling on government expenditure growth (expenditure rule) to strengthen fiscal policy countercyclicality, which is equal to the 3-year average growth rate of potential output.

The European Stability Mechanism (ESM),[21] with a view to simplifying fiscal rules, proposes a two-pillar approach, the first one relating to the 3% of GDP deficit threshold and the second one setting a new debt benchmark of 100% of GDP. The proposal includes a debt rule, whereby countries with public debt over 100% of GDP would have to converge towards this benchmark ratio by 1/20 of their deviation annually, and an operational expenditure rule to replace the MTO (in structural terms), setting the 3-year trend in nominal GDP growth as their growth limit. Exceptions to the debt rule are allowed in cases of major crises, recessions and significant investment gaps. The 3% of GDP budget deficit threshold remains binding and the EDP is maintained, while stressing

16 This is because (i) some countries did not carry out the required fiscal adjustment; (ii) the implementation of fiscal rules and, in some cases, large target overperformance set in the SGP have led to procyclical policies. As a result, debt dynamics deteriorated, as the recessionary impact of excessively tight fiscal policy in downturns effectively cancelled part of the positive contribution of primary deficit reduction; and (iii) support to the financial sector in 2010-19 weighed heavily on public debt dynamics in some countries.

17 Specifically, in Greece the average annual rate of reduction in primary expenditure over the period 2010-14 was around 6% (6.2 p.p. higher than the "expenditure limit" set by the fiscal rule), whereas in 2015-19 this rate remained unchanged (3.9 p.p. higher than the "expenditure limit" set by the fiscal rule).

18 European Fiscal Board, *Annual Reports* 2018, 2019, 2020.

19 Although the EFB proposal is 60% of GDP as a benchmark for debt convergence, it is explicitly stated that, after the end of the pandemic, this threshold has become impracticable.

20 For instance, the level of government debt as a percentage of GDP or the difference between the servicing costs of public debt and the growth rate (r-g).

21 See Francová, O., E. Hitaj, J. Goossen, R. Kraemer, A. Lenarčič and G. Palaiodimos (2021), "EU fiscal rules: reform considerations", ESM Discussion Paper No. 17.

the need for a stronger focus on public investment in the light of the green transition needs. This proposal differs from that of the EFB in that it sets a common rate of government debt reduction for all countries but suggests a new debt benchmark value.

An alternative proposal is that of Blanchard et al. (2021)[22] supporting the abolition of existing numerical fiscal rules in favour of fiscal standards on the basis of stochastic debt sustainability analysis. A country's performance and fiscal risks will be based on the use of stochastic debt sustainability analysis to assess the likelihood that the primary balance exceeds the debt-stabilising primary balance during a reference period. These assessments could be conducted by independent national fiscal councils and/or the European Commission.[23]

5 THE NEED TO STRENGTHEN THE SUSTAINABILITY OF PUBLIC DEBT

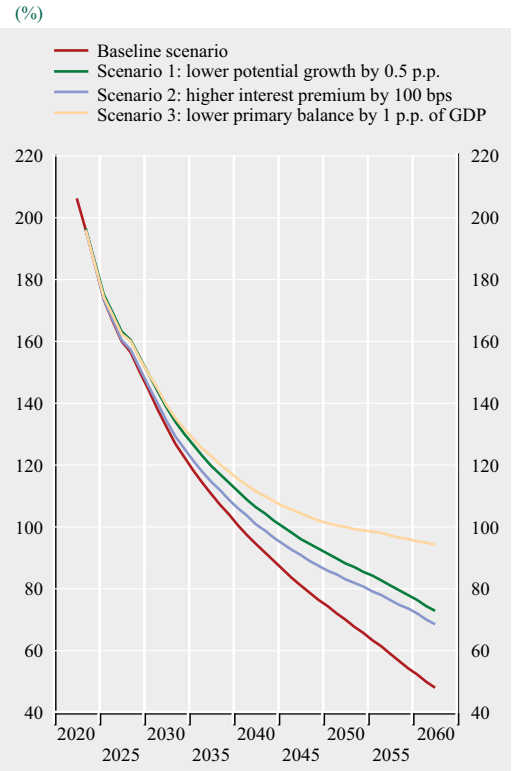
In the post-pandemic period, the adoption of credible and effective fiscal policies aimed at public debt sustainability is more urgent than ever. One of the fundamental weaknesses of the European economy is the high level of public debt, which: (i) limits the room for flexibility to address future challenges; (ii) makes public finances vulnerable to interest rate increases; and (iii) undermines the ECB's ability to respond to rising inflationary pressures. Lower public debt also contributes to reducing divergences between Member States, as debt ratio differentials lead to variations in the fiscal space available to each country to stabilise the economy after a shock and to finance growth-enhancing expenditure. Therefore, in such an uncertain economic environment, it is imperative to strengthen fiscal sustainability and increase the resilience of public finances to adverse shocks.

According to the Bank of Greece's Debt Sustainability Analysis (BoG's DSA), risks from adverse macroeconomic and fiscal shocks to Greek public debt dynamics remain contained in the medium term, assuming sustained commitment to fiscal targets and effective use of NGEU funds (see Charts 2 and 3). The Baseline Scenario assumes broad compliance with SGP's structural balance rule, with primary surpluses averaging 2.2% of GDP during the long-term horizon 2023-60. Moreover, steady-state deflator growth is set at 2.0% and steady-state real GDP growth is set at 1.7%, assuming effective utilisation of NGEU funds. Regarding the assumptions on debt refinancing, the average maturity of new debt is set at around 6.5 years at a refinancing rate that evolves in line with the assumed gradual increase of policy rates, an endogenously determined risk premium that penalises debt-to-GDP ratios above 60% and an exogenous country risk premium. Against the baseline scenario, BoG's DSA considers three alternative risk scenarios: Scenario 1 assumes lower potential growth by 0.5 p.p.; Scenario 2 assumes higher interest premium by 100 bps as of 2022; and Scenario 3 assumes lower primary balance by 1 p.p. of GDP over the long-term forecasting horizon. The analysis indicates that the downward trajectory of Greek public debt is maintained under all scenarios. However, gross financing needs are expected to hover marginally close to the agreed 15% of GDP threshold by the mid-2030s (or even breaching it under an adverse fiscal scenario), thus leaving little room for fiscal loosening.

Greece's public debt, despite its high level, displays increased resilience over the medium term (until around 2030) under several adverse macroeconomic and fiscal scenarios, much higher than in other high-debt euro area countries. According to a European Commission cross-country analysis,[24] public debt in Greece is stabilising and is expected to reach pre-crisis levels earlier than in other high-debt countries, recording the largest drop in the debt-to-

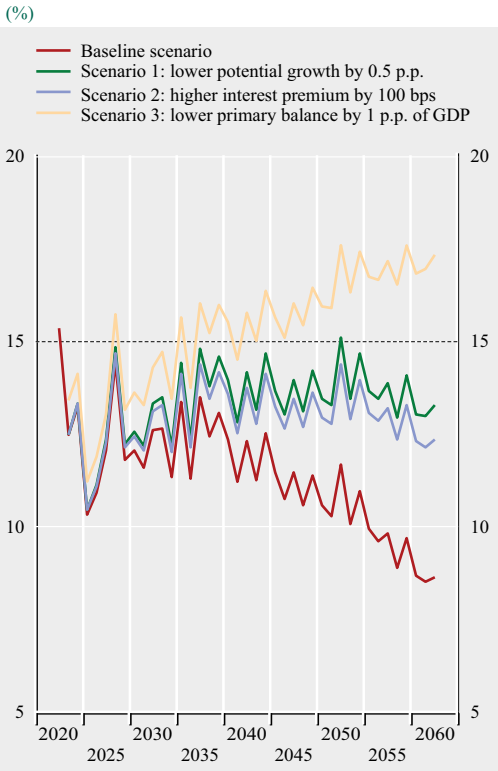
22 Blanchard, O., A. Leandro and J. Zettelmeyer (2020), "Revisiting the EU fiscal framework in an era of low interest rates", PIIE manuscript.
23 Disputes between Member States and the European Commission on the application of the fiscal standards could be resolved by an independent institution, such as the Court of Justice of the EU.
24 European Commission (2022), *Fiscal Sustainability Report 2021.*

Chart 2 Debt/GDP – Baseline and alternative scenarios



Source: Bank of Greece estimates.

Chart 3 Gross financing needs/GDP – Baseline and alternative scenarios



Source: Bank of Greece estimates.

GDP ratio by 2030, both in the baseline scenario and in various alternative scenarios. The strong resilience of Greek public debt dynamics vis-à-vis other countries is attributed to the following factors:

(i) The specific characteristics of Greek public debt,[25] which ensure relatively low interest rate and refinancing risks over the next ten years.

(ii) Greece's fiscal position, as a result of structural fiscal surpluses. This means that, after the pandemic-related emergency support measures are lifted and in the absence of new permanent expansionary fiscal measures, Greece will return to structural primary surpluses, which will reinforce downward public debt dynamics without a need for further fiscal adjustment measures. This is the outcome of the structural fiscal adjustment that has taken place in previous years, as a result of which Greece has outperformed other high-debt countries.

(iii) The positive contribution of the snowball effect, i.e. the difference between the implicit borrowing rate and the nominal GDP growth rate. The snowball effect is a key driver of the rate of change in the debt-to-GDP ratio and reflects, *inter alia*, the impact of the macroeconomic envi-

25 Specifically, according to the latest available data by the Public Debt Management Agency (PDMA, February 2022), in December 2021: (a) 77% of public debt consisted of liabilities to the official sector (including ESM/EFSF loans and GLF loans under the first economic adjustment programme); (b) the share of fixed-rate liabilities amounted to 98.9% of central government debt; (c) the weighted average remaining maturity of general government debt is 20.58 years; (d) the effect of the two previous indicators is that the weighted average time to the next re-fixing of general government debt is 19.76 years; (e) the estimated implicit interest rate of 1.4%, one of the lowest among euro area countries, will therefore remain essentially unchanged over the next 20 years.

ronment on debt dynamics. Compared with other countries, the contribution of this effect to debt reduction is expected to be more than double in the case of Greece, because of the disproportionately high debt level[26] and due to the anticipated large GDP gains from the utilisation of the Recovery and Resilience Facility (RRF) resources.[27]

However, improving the sustainability of public debt and reinforcing its downward trend should be a priority of fiscal policy in the coming years, in order to prevent another debt crisis. Besides, the long maturity of EFSF and ESM loans (over 30 years) calls for a long-term perspective on Greek public debt sustainability, well beyond the medium-term 10-year horizon. It should also be taken into account that the stock of public debt is projected to slightly increase after 2032, once the interest deferral period on the EFSF loan has expired. The main reason for fiscal policy focusing on accelerating debt reduction is that debt's resilience to future adverse shocks will be comparatively weaker, despite its projected lower level. More specifically:

(i) The current favourable characteristics of Greek debt are not of a permanent nature. In the coming years, official sector debt (which is not marketable and thus not exposed to market volatility, has long maturity and carries low interest rates) will be gradually replaced by marketable debt to the private sector, with relatively shorter maturities and higher interest rates. Thus, despite its expected significant de-escalation as a share of GDP, the factors that make Greek debt resilient to negative shocks will gradually weaken in 10 years, as an increasing part of the debt will be subject to market risk.

(ii) The focus should be on annual gross financing needs. In the case of Greece, where the bulk of the debt has not been accumulated on market terms, but rather through official sector low-interest loans with a very long repayment period, a grace period and deferral of interest payments for many years, focusing exclusively on the debt-to-GDP ratio would be misleading. As a result, the sustainability of public finances is also assessed on the basis of the annual gross financing needs criterion for the period up to 2060. In particular, a cap of 15% of GDP in the medium term and a cap of 20% of GDP in the long term were introduced.[28] Despite the expected steady de-escalation of the debt-to-GDP ratio in the coming years, gross financing needs are estimated to remain significantly higher in the medium term vis-à-vis pre-pandemic levels, due to the additional borrowing that was required to finance the fiscal deficits during the health crisis.

(iii) The significant debt-reducing contribution of the snowball effect is expected to decrease over time. The key factors underlying this development will be both the changing macroeconomic environment, with more moderate growth and higher borrowing rates expected in the long term, and the mechanical effect of gradually decreasing debt levels. Accordingly, in the long run, fiscal policy will face growing pressures to contribute more to debt reduction by achieving primary surpluses.

Therefore, in the context of the upcoming reform of the fiscal rules, regardless of the direction it may take, Greece should put particular emphasis on reducing public debt through sustainable budget surpluses in order to make it less vulnerable to future crises. The favourable economic environment in the post-pandemic period makes fiscal adjustment easier, while preserving its countercyclicality and strengthening fiscal credibility.

26 The size of government debt algebraically amplifies the impact of the difference between the implicit nominal interest rate and the nominal GDP growth rate.
27 The output gap in the economy, i.e. the difference between actual and potential output, is estimated to be positive over the 10-year projection period.
28 The criteria for annual gross financing needs were also confirmed in the Eurogroup statement on Greece of 22 June 2018.

6 THE APPLICATION OF THE CURRENT DEBT RULE IN GREECE AND COMPARISON WITH OTHER HIGH-DEBT EURO AREA COUNTRIES[29]

According to the baseline scenario of the Bank of Greece's Debt Sustainability Analysis, which assumes a primary surplus of 2.2% of GDP on average over the period 2023-60 according to the Eurogroup decisions of June 2018,[30] the average annual rate of public debt reduction (Δdebt) is around 6.6 p.p. of GDP in 2023-30 (see Chart 4). When comparing the respective variables for other high-debt euro area countries,[31] we observe that for 2023-30 the average annual rate of public debt reduction in Greece is much higher than that in the other countries, with a much larger positive contribution from both the broader macroeconomic environment and budgetary surpluses. According to Bank of Greece long-term projections, the rate of reduction in the Greek debt ratio gradually decelerates over the coming decades. However, the share of the fiscal balance in downward debt dynamics gradually increases, as the contribution of the snowball effect is fading. This means that, from 2030 onwards, although debt will decrease as a percentage of GDP, its downward dynamics will increasingly rely on the build-up of fiscal surpluses.

The implementation of the current debt rule (60, 1/20 hereinafter)[32] in high-debt euro area countries implies a strengthening of downward debt dynamics, increasing the requirements for fiscal primary surpluses for all countries except Greece. According to the baseline assumptions, Greece will comply with the current debt rule until 2060. However, under all alternative scenarios (most notably, under Scenario 3), Greece fails to comply with the current SGP debt rule after 2030, therefore implying the need to create fiscal buffers in order to account for such risks (see Chart 5). The required primary surpluses come to around 2.2% of GDP on average annually,[33] exceeding the required fiscal target implied by the debt rule (60, 1/20) by almost 0.8 p.p. of GDP, in order to address possible adverse fiscal shock scenarios (see Chart 6). Gross financing needs remain manageable, below the 15% of GDP benchmark, under the baseline scenario. Nevertheless, possible adverse economic shocks could risk breaching the agreed threshold after 2030 (see Chart 7).

On the other hand, the application of the current debt rule is likely to lead to significant fiscal adjustment needs for countries such as Spain, Italy, France and Belgium, as the primary balance requirement relative to the baseline scenario is significantly higher. This additional fiscal effort for most high-debt countries is attributable to the fact that broad compliance with the structural budget balance rule (which is the baseline assumption in our simulations) assumes the realisation of primary deficits[34], while the contribution of the snowball effect in the annual debt reduction is smaller compared with that for Greece. As a result, the declining trend in their debt trajectories is relatively mild, while many of them do not reach pre-pandemic levels by 2030. It should also be noted that over a long-term horizon, contrary to other high-debt countries, Greece has the most favourable contribution of both structural fiscal position and fiscal savings from past pension and social security reforms, whereas other countries will need structural fiscal efforts in order to account for the long-term ageing costs.

29 The following analysis relies on sovereign debt sustainability analysis models, which are partial equilibrium models and tend to underestimate the interaction between macroeconomic and fiscal variables. However, these models are a key tool for designing fiscal strategies and are widely used by public, private and credit rating agencies to identify and assess macroeconomic and fiscal risks.

30 The analysis takes into account the updated macroeconomic and fiscal assumptions of the Bank of Greece. In particular, the baseline scenario incorporates the impact of the pandemic on fiscal aggregates and economic activity. The general government primary balance is assumed to turn into a surplus in 2023 and come to 2.2% of GDP on average in 2024-60 (assuming broad compliance with the SGP's structural budget balance rule). The real GDP growth rate converges to 1.7% over the long term, incorporating the positive impact of the utilisation of NGEU funds on the potential growth rate of the Greek economy. The refinancing rate is 2.8% on average in 2023-60 and the weighted average maturity of new issues is around 7 years.

31 Comparison is made with Belgium, Spain, Italy, France and Portugal.

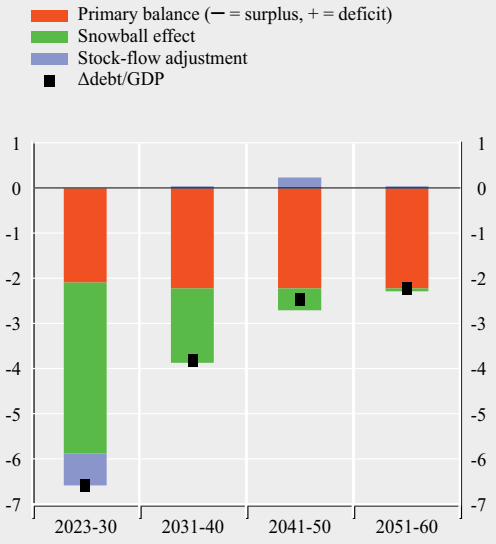
32 For the implementation of the debt rule, the following assumptions are made: The annual rate of reduction in the debt-to-GDP ratio is 1/20 of the distance between the ratio of the previous period and the 60% benchmark level and is revised every three years. By maintaining the baseline assumptions on the snowball effect, we use the debt accumulation accounting equation to calculate the primary surplus requirements to comply with this rule.

33 At the level foreseen in the Eurogroup decisions of June 2018.

34 Or a small balanced primary budget in the case of Italy.

Chart 4 Components of Δdebt/GDP (annual average 2023-60) - Baseline scenario

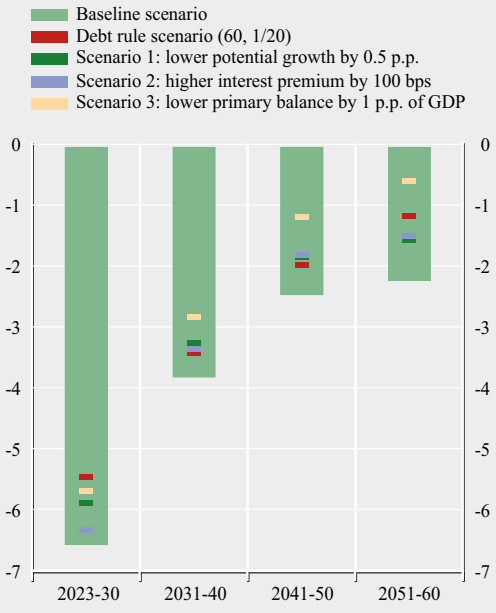
(percentage points of GDP)



Source: Bank of Greece estimates.

Chart 5 Δdebt/GDP (annual average 2023-60) - Baseline and alternative scenarios vs. Debt rule

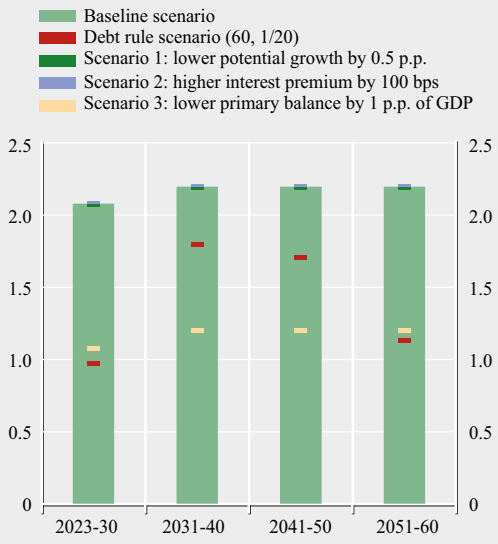
(percentage points of GDP)



Source: Bank of Greece estimates.

Chart 6 Primary surplus (annual average 2023-60) - Baseline and alternative scenarios vs. Debt rule

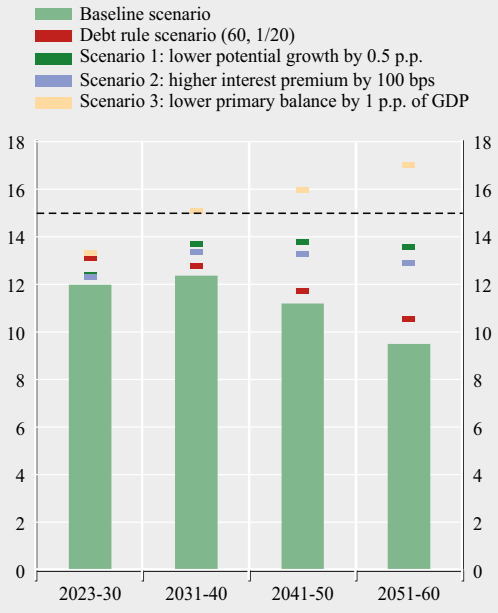
(% of GDP)



Source: Bank of Greece estimates.

Chart 7 Gross financing needs (annual average 2023-60) - Baseline and alternative scenarios vs. Debt rule

(% of GDP)



Source: Bank of Greece estimates.

In conclusion, according to the above analysis, Greece appears to comply with the current debt rule foreseen in the SGP over the medium term. In the long term, however, the country could benefit from any flexibility, following under all circumstances the principle of countercyclicality. Any easing of fiscal targets over the medium term will worsen its debt dynamics, increasing future sustainability risks, gross financing needs and market refinancing risk. By contrast, in the medium term, efforts should be made to strengthen Greece's fiscal credibility by reducing the distance from other euro area countries as quickly as possible. The favourable macroeconomic environment of the next decade would accommodate a further strengthening of fiscal consolidation, provided that the principle of countercyclicality is not breached. On the contrary, over a long-term horizon, when fiscal performance will play a more prominent role in debt-reducing dynamics, Greece could benefit from a possible flexibility of the debt rule to avoid a procyclical fiscal policy.

7 PROPOSED GUIDELINES FOR THE REFORM OF THE EUROPEAN FISCAL RULES

The fiscal footprint of the pandemic crisis and the threat of increased divergence among euro area economies warrant a reform of the European fiscal rules, with debt sustainability as a top priority. The new fiscal framework should aim at increasing the capacity of fiscal policies to stabilise the economic cycle, thereby contributing to monetary policy normalisation. Therefore, the new rules should take into account the new macroeconomic environment and the uncertainties that accompany it, in order to achieve a more effective coordination of national fiscal policies.

The fiscal framework could be revised towards:

(i) Strengthening the countercyclicality of fiscal policy.[35] Retrenchment in good times and expansion in downturns are particularly important for both macroeconomic stabilisation and fiscal sustainability.

(ii) Setting a debt anchor as a medium-term fiscal objective, combined with a single operational expenditure rule: At the current juncture, as shown by the above analysis, ensuring public debt sustainability becomes a key medium- to long-term fiscal policy objective. The operational rule to achieve this objective should be to control the rate of change in government primary expenditure, since it has been regarded as a rule of fiscal discipline that enhances the countercyclicality of fiscal policy and promotes an effective mix of adjustment measures when necessary.[36] However, an expenditure rule alone is not capable of preventing deficits and increases in public debt originating on the revenue side. This is why it should apply alongside other rules (e.g. minimum revenue thresholds) to ensure fiscal discipline.

(iii) Maintaining current benchmark levels,[37] with flexibility in the rate of adjustment where appropriate: Although they seem

35 Larch, M., E. Orseau and W. van der Wielen (2021), "Do EU fiscal rules support or hinder counter-cyclical fiscal policy?", *Journal of International Money and Finance*, 112; Debrun, X., L. Moulin, A. Turrini, J. Ayuso-i-Casals and M. Kumar (2008), "Tied to the mast? The role of national fiscal rules in the European Union", *Economic Policy*, 23, 298-362; and Thygesen, N., R. Beetsma, M. Bordignon, X. Debrun, M. Szczurek, M. Larch, M. Busse, M. Gabrijelcic, L. Jankovics and J. Malzubris (2021), "The EU fiscal framework: A flanking reform is more preferable than quick fixes", *VoxEU.org*.

36 European Fiscal Board (2018), *Annual Report*, and European Fiscal Board (2019), *Assessment of European fiscal rules with a focus on the six and two-pack legislation*. The expenditure rule has also been favoured by other economists in the public debate on the reform of the SGP: Barnes, S. and E. Casey (2019), "Euro area budget rules on spending must avoid the pro-cyclicality trap", *VoxEU.org*; Bénassy-Quéré, A., M. Brunnermeier, H. Enderlein, E. Farhi, M. Fratzscher, C. Fuest, P. Gourinchas, P. Martin, J. Pisani-Ferry, H. Rey, I. Schnabel, N. Véron, B. Weder di Mauro and J. Zettelmeyer (2018), "How to reconcile risk sharing and market discipline in the euro area", *VoxEU.org*; and Darvas, Z., P. Martin and X. Ragot (2018), "The economic case for an expenditure rule in Europe", *VoxEU.org*.

37 Deficit: 3% of GDP, debt: 60% of GDP. Although there are many studies suggesting that there is no single "public debt limit" for all countries beyond which economic growth is slowing, most agree that high debt levels are associated with low growth and increased volatility. For more details, see Caner, M., T. Grennes and F. Koehler-Geib (2010), "Finding the Tipping Point – When Sovereign Debt Turns Bad", World Bank, Policy Research Working Paper No. 5391; and Pescatori, A., D. Sandri and J. Simon (2014), "Debt and Growth: Is There a Magic Threshold?", IMF Working Paper No. 14/34.

outdated in the present economic context, current benchmark levels are enshrined in EU treaties, which are difficult to amend and require broader consensus among Member States and lengthy procedures. The pace of debt reduction is easier to modify, so as to ensure a sustainable downward path through a realistic and credible fiscal adjustment, which would take into account the broader macroeconomic environment and fiscal position of each country, while maintaining the principle of countercyclicality. Changing the reduction rate of public debt would require unanimity on amendments to secondary EU legislation, through a set of agreements among countries.

Changes in the pace of adjustment to the current debt rule could be limited, as its application already assumes a differentiated fiscal path for each country, depending on the different economic conditions and fiscal position of each Member State (heterogeneity across countries).[38] Furthermore, differentiated rules and various exceptions do not help simplify and enhance the credibility of the fiscal framework. Therefore, flexibility should depend on whether the fiscal adjustment required to comply with the debt rule is procyclical.

(iv) Simplification: The structure of the new framework should be simple and transparent. To this end, the new rules should be less dependent on non-observable variables that complicate their comprehension and effective monitoring. The proposed operational expenditure rule relies on the rate of change in potential output, which is less subject to measurement problems.

(v) An effective and reliable mechanism for surveilling the implementation of the new framework: Governments' compliance with the new rules is essential for their sustainable implementation and credibility. Improving the institutional set-up for surveilling compliance with fiscal rules is all the more necessary if more flexibility is granted to take into account country-specific circumstances. It is therefore proposed to strengthen national independent fiscal institutions (e.g. fiscal councils). Alongside the European institutions, national fiscal councils could contribute to better compliance with the rules and to more effective policy surveillance and evaluation, thereby strengthening fiscal credibility and ownership of the new fiscal framework.

(vi) Safeguarding public investment: Given the pressing needs for green and digital transformation of the economies in the coming years, the practice of cutting investment spending as a means of achieving fiscal targets should come to an end.[39] The priority given to public debt reduction as a fiscal policy objective does not allow for investment expenditure financed by new borrowing to be excluded from the new fiscal rules and, in particular, from the debt rule. Targeted investment expenditure could be financed through a system of transfers, which would be financed through the issuance of common European debt by a permanent European mechanism (see below). In any case, excluding various expenditure categories —the classification of which is complex in any event— from the fiscal rules would

38 The smaller the snowball effect, the larger the primary surplus needed to achieve the same debt reduction and thus the need for fiscal adjustment (depending on the fiscal position of each country). Therefore, the primary surplus requirement needed to comply with the current rule in high-debt countries may be lower than in countries with relatively lower debt levels, if the contribution of the snowball effect in the former is significantly higher than in the latter. Therefore, countries with a high debt level do not necessarily require a high primary surplus to comply with this rule. Also, the fiscal adjustment needs of countries with a structural fiscal position in surplus are smaller than those of countries with structural primary deficits. Lastly, when the current debt rule was introduced, it did not aim at the convergence of Member States' debt-to-GDP ratios to 60% of GDP in 20 years (since the adjustment rate is revised every 3 years, depending on the debt level and its distance from the benchmark), but mainly at promoting fiscal adjustment in high-debt countries, ensuring a permanent debt-reducing path and asymptotic convergence to the benchmark.

39 The practice of cutting public investment in the past, with negative effects on economic growth, is not a weakness of the current fiscal rules, but a common policy option for governments that refused to promote structural fiscal measures to achieve the targets.

hamper the simplification and credibility of the fiscal framework.

(vii) The new NGEU instrument should become permanent, so as to function as a central fiscal capacity to increase public investment. By issuing common European debt, the NGEU is instrumental in creating fiscal space and enhancing convergence among European economies, as the high-debt countries benefit more from the available funds. NGEU financial support will help reduce the investment gap and support the growth of European economies in the coming years. Combined with a low interest rate environment in the medium term, NGEU resources will help countries improve their debt dynamics by making the required fiscal adjustment easier.

Therefore, the objective of boosting (green, digital) public investment could be achieved by making the NGEU a permanent central mechanism for fiscal transfers beyond 2026. Although it is still under development, its operational design provides a model for the future of economic governance in the euro area by combining fiscal transfers with fiscal responsibility at a transnational level.[40]

40 As the NGEU is centrally organised, there are fewer incentives to classify all investments as "green" or "digital" in order to be exempt from fiscal rules.

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Sofia Anyfantaki
Bank of Greece, Economic Analysis and Research Department

Petros Migiakis
Bank of Greece, Economic Analysis and Research Department

Katerina Paisiou
Bank of Greece, Climate Change and Sustainability Centre

ABSTRACT

Addressing climate change through mitigation and adaptation measures requires changes in policies, technologies and consumption behaviours towards a low-emissions model of growth. These structural changes require appropriate financial solutions, in order to scale up financial flows that support sustainable growth. This paper focuses on the European dimension and considers the role of financial markets in the process of reducing greenhouse gas (GHG) emissions and promoting climate change mitigation and adaptation. Global green bond markets have grown rapidly in recent years. Based on issue- and issuer-specific data, we find that the global market activity for financing projects within the scope of a green bond issuance has accelerated during the last years, with the aggregate amount of bonds issued in the period 2019-21 almost tripling compared with the period 2014-18. Moreover, we show that European markets and issuers lead this development, while private sector entities are increasingly making use of green bond markets as a source of funding. On the other hand, funding from green bond markets has been directed to few sectors of the economy, underlining the need for some policy-related initiatives. The increase in green bond issuance has come during a period of easy financial conditions, which could further highlight the need for policy initiatives aimed at enhancing the provision of incentives to investors towards green financing in the present changing financial market landscape. The improvement of the credibility, comparability and transparency of ESG ratings and assessments of CRAs is important to support sound investment decision-making and risk management, including those of central banks, which are increasingly incorporating climate change issues in their operations.

Keywords: green bonds; green finance; ESG; credit ratings; greenwashing

JEL classification: G10; G20; O16

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ΠΡΑΣΙΝΗ ΧΡΗΜΑΤΟΔΟΤΗΣΗ ΣΤΗΝ ΕΥΡΩΠΗ: ΑΝΑΠΤΥΞΗ ΚΑΙ ΠΡΟΚΛΗΣΕΙΣ

Σοφία Ανυφαντάκη
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

Πέτρος Μηγιάκης
Τράπεζα της Ελλάδος, Διεύθυνση Οικονομικής Ανάλυσης και Μελετών

Κατερίνα Παϊσίου
Τράπεζα της Ελλάδος, Κέντρο Κλιματικής Αλλαγής και Βιωσιμότητας

ΠΕΡΙΛΗΨΗ

Η αντιμετώπιση της κλιματικής αλλαγής μέσω μέτρων μετριασμού και προσαρμογής απαιτεί αλλαγές στις πολιτικές, τις τεχνολογίες και τις καταναλωτικές συμπεριφορές προς ένα μοντέλο ανάπτυξης χαμηλών εκπομπών. Αυτές οι διαρθρωτικές αλλαγές απαιτούν και τις κατάλληλες χρηματοοικονομικές λύσεις, προκειμένου να αυξηθούν οι χρηματοοικονομικές ροές που στηρίζουν τη βιώσιμη ανάπτυξη. Η παρούσα μελέτη εστιάζει στην Ευρώπη και εξετάζει το ρόλο των χρηματοπιστωτικών αγορών στη διαδικασία μείωσης των εκπομπών αερίων του θερμοκηπίου και στην προώθηση του μετριασμού και της προσαρμογής στην κλιματική αλλαγή. Οι παγκόσμιες αγορές πράσινων ομολόγων έχουν αναπτυχθεί ραγδαία το τελευταίο διάστημα. Με βάση δεδομένα για την έκδοση και τον εκδότη, διαπιστώνουμε ότι η δραστηριότητα της παγκόσμιας αγοράς για τη χρηματοδότηση έργων στο πλαίσιο έκδοσης πράσινων ομολόγων έχει επιταχυνθεί τα τελευταία χρόνια, με τα συνολικά ποσά των ομολόγων που εκδόθηκαν την περίοδο 2019-21 σχεδόν να τριπλασιάζονται σε σύγκριση με την περίοδο 2014-18. Επιπλέον, δείχνουμε ότι οι ευρωπαϊκές αγορές και οι Ευρωπαίοι εκδότες ηγούνται αυτής της εξέλιξης, ενώ οι οντότητες του ιδιωτικού τομέα χρησιμοποιούν όλο και περισσότερο τις αγορές πράσινων ομολόγων ως πηγή χρηματοδότησης. Ωστόσο, η χρηματοδότηση από τις αγορές πράσινων ομολόγων κατευθύνεται σε λίγους μόνο τομείς της οικονομίας, γεγονός που υπογραμμίζει την ανάγκη ανάληψης πρωτοβουλιών από την πλευρά της πολιτικής. Η αύξηση της έκδοσης πράσινων ομολόγων σημειώθηκε σε μια περίοδο ευνοϊκών χρηματοπιστωτικών συνθηκών, γεγονός που ενισχύει περαιτέρω την ανάγκη για πρωτοβουλίες πολιτικής με στόχο την παροχή κινήτρων στους επενδυτές για πράσινη χρηματοδότηση στο παρόν μεταβαλλόμενο τοπίο της αγοράς. Οι επενδυτικές στρατηγικές επικεντρώνονται πλέον σε κριτήρια περιβαλλοντικά, κοινωνικά και διακυβέρνησης (ESG), έτσι ώστε οι επιχειρήσεις να αναδεικνύουν την καλύτερη διαχείριση του κλιματικού κινδύνου, το βελτιωμένο περιβαλλοντικό αποτύπωμά τους, αλλά και την αξία που δημιουργούν για την κοινωνία. Η αύξηση της αξιοπιστίας, της συγκρισιμότητας και της διαφάνειας των αξιολογήσεων ESG των οργανισμών πιστοληπτικής αξιολόγησης είναι σημαντική για την ορθή λήψη επενδυτικών αποφάσεων και διαχείριση κινδύνων εκ μέρους των επιχειρήσεων, αλλά και εκ μέρους των κεντρικών τραπεζών, οι οποίες ενσωματώνουν ολοένα περισσότερο παραμέτρους της κλιματικής αλλαγής στις δραστηριότητές τους. Η ανάπτυξη κοινών προτύπων, σημάτων βιωσιμότητας και κριτηρίων αξιολόγησης πιστοληπτικής ικανότητας θα συμβάλει σε πιο εμπεριστατωμένες αξιολογήσεις και αποφάσεις για τη χρηματοδότηση και θα ενισχύσει την αξιοπιστία των αγορών, ενώ θα μειώσει τον κίνδυνο χρήσης ψευδεπίγραφης οικολογικής ταυτότητας (greenwashing). Παράλληλα, η εφαρμογή ψηφιακών τεχνολογιών στην πράσινη χρηματοδότηση μπορεί να στηρίξει τη βιώσιμη ανάπτυξη, μέσω της αύξησης των χρηματοδοτικών πόρων και της μείωσης του κόστους πράσινης μετάβασης.

GREEN FINANCE IN EUROPE: ACTORS AND CHALLENGES*

Sofia Anyfantaki
Bank of Greece, Economic Analysis and Research Department

Petros Migiakis
Bank of Greece, Economic Analysis and Research Department

Katerina Paisiou
Bank of Greece, Climate Change and Sustainability Centre

1 INTRODUCTION

Climate change is one of the most pressing issues of our time. The Paris Agreement, a legally binding international treaty on climate change that was adopted by 196 parties in 2015, aims to limit global warming to well below 2 degrees Celsius (preferably to 1.5˚) compared with pre-industrial levels. Meeting the Paris objectives requires sustained action over many decades to reduce or prevent the emissions linked to human activities and demands a reshaping of the global economy towards a more sustainable growth model. Realising deep decarbonisation of economies to mitigate climate change needs innovative approaches, coupled with financial solutions to scale up financial flows that support sustainable development.[1]

The EU's initial commitment was to reduce greenhouse gas (GHG) emissions by at least 40% by 2030 compared with 1990. In September 2020, the European Commission (EC) proposed to raise the 2030 GHG emissions reduction target to at least 55% relative to 1990. The 40% target is implemented through the EU Emissions Trading System (EU ETS), the world's first major carbon market set up in 2005.[2] The EU ETS has proven to be an effective tool in driving emissions reductions cost-effectively: installations covered by the system reduced emissions by 42.3% in the period 2005-20. However, the tightening of the overall EU emissions target to 55%, compared with 1990, necessitates steeper GHG emissions reductions.

Largely focusing on the European dimension, this paper considers the respective role of financial markets in the process of mitigating GHG emissions and promoting adaptation to climate change. Well-functioning and integrated capital markets would complement banks as an effective source of financing sustainable growth and would thus improve the allocation of capital in the economy, facilitating entrepreneurial, risk-taking activities and investment notably in green technologies and other long-term projects. Green bonds can play a significant role when it comes to financing a more sustainable European economy.

The EU green capital markets are dynamic and rapidly growing, which may foreshadow the intensification of investment efforts in sustainable projects and the increase of green bond issuance in the future. The EU green bond markets are characterised by a higher degree of integration and investors' preference for cross-border holdings (limited "home bias"), which may also be attributed to the lack of domestic supply of green bonds (European Central Bank 2022). Furthermore, investment funds that meet environmental, social and governance (ESG) criteria appear to be more stable, as, compared with other types of collective

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1 Communication from the Commission, The European Green Deal, 11.12.2019.

2 The EU ETS operates in all EU countries plus Iceland, Liechtenstein and Norway, limits emissions from around 10,000 installations and covers around 40% of the EU's greenhouse gas emissions. It is a "cap and trade" system whereby, within a cap set on the total amount of certain greenhouse gases than can be emitted by the installations covered by the system, installations buy or receive emissions allowances, which they can then trade with one another as needed. The system operates in trading phases and is currently in Phase IV (2021-30). See https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en.

investment undertakings, investors are less likely to withdraw their investments after a negative performance (Alogoskoufis et al. 2021; Capota et al. 2021).

In this paper, we describe the development of green bond markets during the past decade, by using a large security-level dataset, including issue- and issuer-specific characteristics. We find that the market activity for financing projects within the scope of a green bond issuance has accelerated over the past few years, with the aggregate amount of bonds issued in 2019-21 standing at about three times the aggregate amount of bonds issued in 2014-18. Moreover, we also find that (a) Europe, as a location of both green bond markets and green bond issuers, has a leading role in this development and (b) private sector entities are increasingly making use of green bond markets as a source of funding. On the other hand, we also find that funding from green bond markets has been directed to few sectors of the economy; a finding that may underline the need for policy-related initiatives, in order to involve more sectors of the economy. Finally, we note that the increase in green bond issuance has come during a period of easy financial conditions; this stylised fact may highlight the need for policy initiatives providing investors with incentives to continue their green financing in the present changing market landscape.

The rest of the paper is structured as follows: Section 2 describes briefly the green capital markets in the European Union, outlining EU actions on financing sustainable growth and the landscape of the EU green bond market. Section 3 investigates how ESG criteria are embedded in the current credit ratings and how they are related to green bonds. Section 4 addresses some forward-looking issues related to the risk of greenwashing, describing a number of EU initiatives in this direction, explains the role of central banks in combatting climate change and touches on the role of digital finance. Finally, Section 5 presents the concluding remarks of this study.

2 GREEN FINANCING

2.1 EU ACTION ON FINANCING SUSTAINABLE GROWTH

The EU's main growth strategy to transition to a sustainable economic model is the European Green Deal presented by the EC on 11 December 2019, with a promise to make Europe the first climate-neutral continent by 2050, while ensuring that no one is left behind.[3] In July 2021, the EC released the 2030 Climate Target Plan to further reduce net GHG emissions by at least 55% by 2030 ("Fit for 55").[4] Taking into account that renewables are a cheap, clean and potentially endless source of energy, the present environment of rising energy prices, amid a geopolitical turmoil following Russia's invasion of Ukraine, intensifies the need for a clean energy transition. In this respect, the EU presented REPowerEU, a joint European action for more affordable, secure and sustainable energy and independence from Russian fossil fuels well before 2030.[5]

To achieve the goals set by the European Green Deal, the EC has pledged to mobilise at least EUR 1 trillion in sustainable investments over the next decade, requiring an unprecedented shift in both public and private funds to finance the transition. According to the Sustainable Europe Investment Plan (also known as the European Green Deal Investment Plan), private and public sustainable investments will be mobilised over the next decade through the EU budget, together with additional resources under the InvestEU programme.[6] It is also estimated that Europe will need around EUR 350 billion of annual extra investment to meet its

3 Communication from the Commission, The European Green Deal, and Annex to this Communication, 11.12.2019.
4 Communication from the Commission, "Fit for 55": delivering the EU's 2030 Climate Target on the way to climate neutrality, 14.7.2021.
5 REPowerEU: Joint European action for more affordable, secure and sustainable energy, press release of 8.3.2022.
6 Communication from the Commission, Sustainable Europe Investment Plan, 14.1.2020. The plan is accompanied by the Just Transition Mechanism, which will mobilise investments of at least EUR 143 billion to support the regions which are heavily reliant on emission-intensive activities to transition to new economic activities, as it is important that no one is left behind towards the path to a climate-neutral Europe by 2050.

2030 emissions target in energy systems alone. This is in addition to around EUR 130 billion for other environmental goals. A combination of funds from the EU budget, as well as public and private investments is therefore required. The EC has emphasised that it will continue to work on how to further mobilise resources to meet the objective of climate neutrality. Capital markets are thus an integral part of this process.

To help improve the flow of direct investments towards financing the transition, the EC has adopted a new strategy for financing the transition to a sustainable economy, which includes actions in a number of areas.[7] Furthermore, sustainability, along with digital growth, is at the heart of the EU's recovery plan from the coronavirus (COVID-19) pandemic towards a greener, more digital and more resilient Europe.[8] Through its 2021-2027 long-term budget (Multiannual Financial Framework – MMF) and the NGEU instrument, the EU intends to spend up to EUR 605 billion in projects addressing climate crisis and EUR 100 billion in projects supporting biodiversity. Of the EUR 750 billion allocated for the NGEU, the EC intends to issue up to EUR 250 billion, or 30%, in green bonds by end-2026, making the EU the largest green bond issuer in the world.[9]

Also, emerging technologies could be used to support green finance. The EC has in fact stressed the need to take advantage of the opportunities offered by digital technologies for sustainable finance.[10] Moreover, as highlighted by the objectives and conclusions of the 26th Conference of the Parties on Climate Change (COP26) in 2021, there is a clear link between sustainable finance and technological innovation.[11] Technology provides solutions to channel finance towards sustainability objectives, while deployment of technology could contribute to a better monitoring of compliance with the relevant green standards and requirements.

Overall, the shift to net zero emissions and the digital transition require major investments, and public budgets will fall far short of the required funding.[12] Capital markets can provide innovative tools to close the investment gap. At present, compared with other parts of the world, euro area non-financial corporations seem to rely more on banks than on capital markets for funding, which, among other reasons, might be attributed to the tax bias towards debt finance over equity and the preference for shorter-term funding commitments. However, investments for sustainable growth and innovation technologies have certain characteristics that may be less suited for bank lending such as their relatively high-risk profile and their long maturity, which may not be available in the banking sector (see for example De Haas and Popov 2019). Moreover, cross-border integration of finance in the euro area is limited mainly due to national institutional differences, such as differences in insolvency laws. These create impediments to mobilising all available resources —both banking and non-banking— to finance the green transition. In this respect, additional efforts in deepening and integrating the EU's capital markets through the completion of the Capital Markets Union (CMU) is of strategic importance to the European economy (European Commission 2020).

For the EU to deliver the twin transition towards a green and digital economy, and mobilise the necessary resources to get there,

7 Communication from the Commission, Strategy for Financing the Transition to a Sustainable Economy, 6.7.2021.
8 In particular, the Recovery and Resilience Facility (RRF) Regulation requires each Member State to dedicate at least 37% of its recovery and resilience plan total allocation to climate objectives and 20% to digitalisation objectives.
9 Furthermore, up to EUR 100 billion (of which EUR 91.8 billion had already been disbursed by 22 March 2022) of EU SURE bonds will be issued as social bonds.
10 See footnote 7.
11 The global debate on how emerging technological innovations could be used to support green financing began in 2014, when the United Nations Environment Programme (UNEP) launched an Inquiry into the Design of a Sustainable Financial System. In 2016, green finance attracted the interest of G20 leaders, as the G20 Green Finance Study Group was established under the Chinese chairmanship.
12 The Digital Compass proposed by the Commission sets out the Union's digital targets for 2030. To achieve these ambitions, the EU needs to step up investments in key digital technologies, as well as in the relevant skills. To foster the digital transition, a 2020 estimate shows that additional investments of around EUR 125 billion are needed per year. The digital transition will also contribute to the green objectives, with synergies in many areas of a smart circular economy. See https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1467.

market financing —which is much less developed relative to international peers— should be furthered. It is important to align the financial system with sustainable development and address risks related to climate change. In this respect, in 2018, the EC developed an initial action plan on financing sustainable growth with ten key actions envisaged.[13] Following that, on 6 July 2021, the EC published the Renewed Sustainable Finance Strategy, which includes four areas where additional actions are needed to create the enabling framework for private investors and the public sector to facilitate sustainable investment.[14] The EU since 2018 has been establishing the building blocks for a sustainable financial system, including the Sustainable Finance Taxonomy Regulation (Taxonomy Regulation), the Sustainable Finance Disclosure Regulation, the Corporate Sustainability Reporting Directive and the European Green Bond Standard.

2.2 WHAT IS A GREEN BOND?

In the light of the critical role of the financial sector for providing sufficient funds, sustainable finance is receiving more attention. Sustainable finance is a broad term, which usually refers to the process of taking ESG considerations into account when making investment decisions in the financial sector. Environmental considerations might include climate change mitigation and adaptation as well as other factors, such as the preservation of biodiversity, pollution prevention and the circular economy. In the EU's policy context, sustainable finance has a key role in delivering the EU's commitments on climate and sustainability objectives. It is understood as "finance to support economic growth while reducing pressures on the environment and taking into account social and governance aspects".[15] Within the context of sustainability, there are manifold ways of defining green finance: "Green finance involves collecting funds for addressing climate and environmental issues (green financing), on the one hand, and improving the management of financial risk related to climate and the environment (greening finance), on the other".[16] Green finance is growing fast through various financial instruments available to issuers and investors, such as green bonds, green loans, sustainable bonds, sustainability-linked bonds and sustainability-linked loans, blue bonds, and social bonds.

Green bonds are part of the universe of sustainability-related fixed-income instruments aimed at financing predetermined projects that support environmental objectives. They differ from conventional bonds in that the use of proceeds is specified in their terms when issued, with impact reporting provided thereafter. However, they rank *pari passu* to non-green bonds, as the credit risk is that of the overall company, and not of the individual project (Cong et al. 2020). As such, they are by and large legally binding for the issuer as any other bond, which means that a breach in the terms and conditions of the issue may result in the default of the issuer. This is not to say that if a project financed by the market fails to meet its environmental objectives, this will lead to a default; in fact, there has been no default of a green bond issuer, due to a breach of the environmental purposes of the issue. On the other hand, it is frequent to incorporate a penalty premium to be paid by the issuer, if the environmental goals, set out in the prospectus distributed to investors, are not met. In this way, even indirectly, green bonds incorporate a mechanism to enforce their environmental goals.

There is no official or mandatory labelling framework for green bonds. On the other hand, green bonds may be distinguished into those that are labelled as green by international financial market associations, or other accepted third parties, and those self-labelled as green by the bond issuers. The first category includes those bonds that comply with a framework of principles, such as the Green Bond

13 https://ec.europa.eu/info/publications/sustainable-finance-renewed-strategy_en#action-plan.
14 https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3405.
15 https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/overview-sustainable-finance_en#what.
16 https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/679081/EPRS_BRI(2021)679081_EN.pdf.

Principles of the International Capital Market Association (ICMA)[17] or the Climate Bonds Standard of the Climate Bonds Initiative.[18] These frameworks are based on four pillars: use of proceeds; project evaluation and selection; management of proceeds; and impact reporting. A verification by an external party —for example, from auditors or credit rating agencies (CRAs)— is often obtained to evaluate the compliance of the instrument with the framework at pre- and post-issuance, verifying the allocation of funds to eligible green projects. Reporting is provided on a regular basis to provide information on the use of proceeds, the activities financed and the impact of the financed activities using qualitative and quantitative indicators, where possible.

Three methods are commonly used to label a bond as green: the use of proceeds model; the counterparty profile model; and the hybrid model.

- The use of proceeds model considers how the proceeds of the bond will be used and the issuer may only use the funds raised to finance projects with an earmarked environmental purpose. The proposed European Green Bond Standard is based on this model.

- The counterparty profile model considers how the proceeds of the model will be used to finance the general operations of the issuer (rather than specific projects) with explicit sustainability targets which are linked with the bond terms (for example, achievement of climate-related goals).

- The hybrid model considers both the use of proceeds of the issuance and the issuer's profile. For example, the proceeds from transition bonds may help a company to improve its environmental and sustainability profile.

Despite the fact that the interest in sustainable investment is increasing, the lack of hard and comparable environmental data limits the ability of investors to make informed decisions that reflect environmental issues. In this regard and as a response to the need for establishing a clear set of criteria on how to assess the true "greenness" of green bonds and foster investor confidence, the EC proposed a European green bond standard (EUGBS) in July 2021. In addition, the EU Taxonomy provides a framework with criteria to be considered for labelling activities as "sustainable" although there is still room for improvements, for example in the scope and the application of the framework, in order to facilitate capital flows towards green investments and projects that support transition. The development of common standards and labels for green bonds will increase transparency and comparability, supporting the scaling-up of financing for green investments, and it may enhance the credibility of markets, reducing also the risk of so-called "greenwashing" (for example, if a product is labelled as green when such claim is not true; see also Section 4.1). Furthermore, the improvement of corporate practices for sustainability and the increase of the relevant disclosures, e.g. the obligation of companies to make public their GHG emissions reduction targets and environmental performance, will help to direct investments towards financing the transition to a low-emissions economy.

2.3 GREEN BOND MARKETS

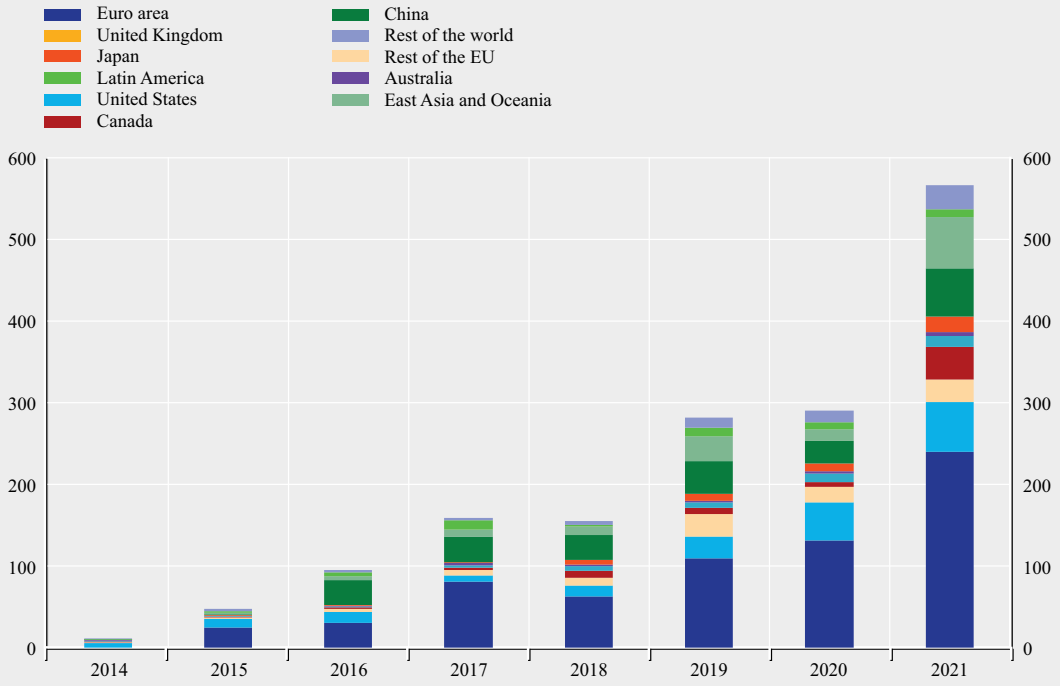
The EU can already be considered to have a lead among the green capital markets. At present, the green bond market displays a higher degree of integration across the euro area than the aggregate bond market. Green bonds are roughly twice as likely as other types of bonds to be held cross-border within the euro area. However, this may be attributed to the lack of domestic supply in those Member States where green bond markets are underdeveloped, since as soon as domestic green bond markets become available, the level of integration decreases for these instruments as well.

At the beginning of 2022, the green bond market has seen a remarkable growth, with USD

17 ICMA, Green Bond Principles, June 2021.
18 Climate Bonds Standard.

Chart 1 Issuance activity in the global green bond markets

(USD billions)



Sources: Refinitiv and Bank of Greece.
Notes: The bars present the annual amounts (in USD billions) raised in bonds that are classified by Refinitiv as green, from 2014 to 2021, per country of residence of the bond issuer and per year of bond issuance. Then, selected countries are grouped according to geoeconomic criteria (e.g. bonds issued by euro area issuers are grouped into the category "Euro area", bonds issued by entities located in Latin American countries are grouped into "Latin America", and so on). In total, 5,531 individual bonds have been grouped into the categories mentioned in the chart label.

1.61 trillion in cumulative issuance since 2014. Global annual issuance has increased each year since 2014, accounting for a total value of USD 470 billion over the period 2014-18 and USD 1.14 billion from 2019 onwards (see Chart 1). In 2021 alone, green bonds totalling USD 567 billion were issued, an amount higher than the total value of issuances for the period 2007-18 and more than double the value of green bonds issued in 2019 and 2020.

It is also worth noting that besides green bonds, sustainability and social bond issuances account for about a third of the outstanding issuances of the green bond market each. For social bonds, France is the largest issuer, followed by supranationals, the United States, South Korea, Chile and Japan. At a regional level, the EU is the leading issuer. For sustainability bonds, supranationals are leading the growth of issuances, followed by the United States, South Korea, France and the United Kingdom. At a regional level, the EU is again the leading issuer (see also Climate Bonds Initiative 2021).

The large growth of the green bond market and the acceleration of the corresponding issuance activity are largely driven by the euro area capital markets. Specifically, in 2021, out of the USD 567 billion of international green bond issues, USD 321 billion was issued in the euro area. Of this, USD 219 billion was issued by euro area issuers in euro area markets, while another USD 21 billion has been issued by euro area residents abroad. Since 2014, USD 703 billion has been issued by euro area governments and companies based in a euro area

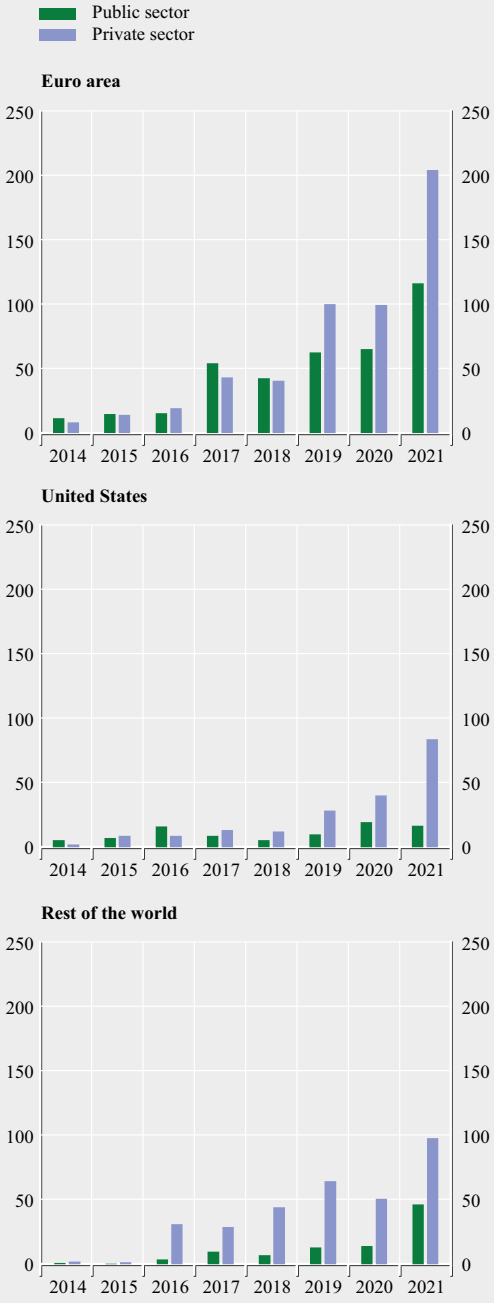
country irrespective of the market of issuance, while USD 564 billion has been issued in euro area bond markets. Including non-euro area bond issuers, green bond issuance in euro area markets in 2014-21 stood at USD 915 billion. This observation shows that the euro area green bond markets have a more international scope. In terms of individual countries, the United States was the largest issuer of green bonds outstanding in 2021, followed by China, Germany, France and the United Kingdom.

Green bond issuances are increasingly carried out by the private sector, while public sector issuances (states, regions and related entities) continue to provide funding for projects and investment programmes related to broader sustainability goals (see Chart 2). This development is encouraging, as long as the trend continues and European companies lead the way in financing sustainable productive activities. From an economic perspective, the heavy bond issuance from the European private sector may be an indication of an acceleration of investments towards achieving the goals of sustainable growth, which these bonds finance. Investments in turn will enable the transition of the underlying economies to more sustainable forms of production. Nevertheless, taking into account that production in today's globalised world is interlinked across regions, the lag of the private sector in other regions of the world is not encouraging with regard to the dynamics of the transition towards greener forms of production on a global scale.

The characteristics of the new bonds issued per year also suggest that the euro area green bond market has the potential to contribute to the economic transition of the European economy towards a greener and more sustainable economic model. In particular, green and sustainable bonds issued by euro area entities have a long-term maturity, with the median maturity of bonds issued since 2013 being 12.6 years. In the years after the signing of the Paris Agreement in 2015, the weighted average maturity of new bonds issued per year rose from 9.9 to 15 years in 2021 (see top panel of Chart 3). The

Chart 2 Green bond issuance per sector of the economy

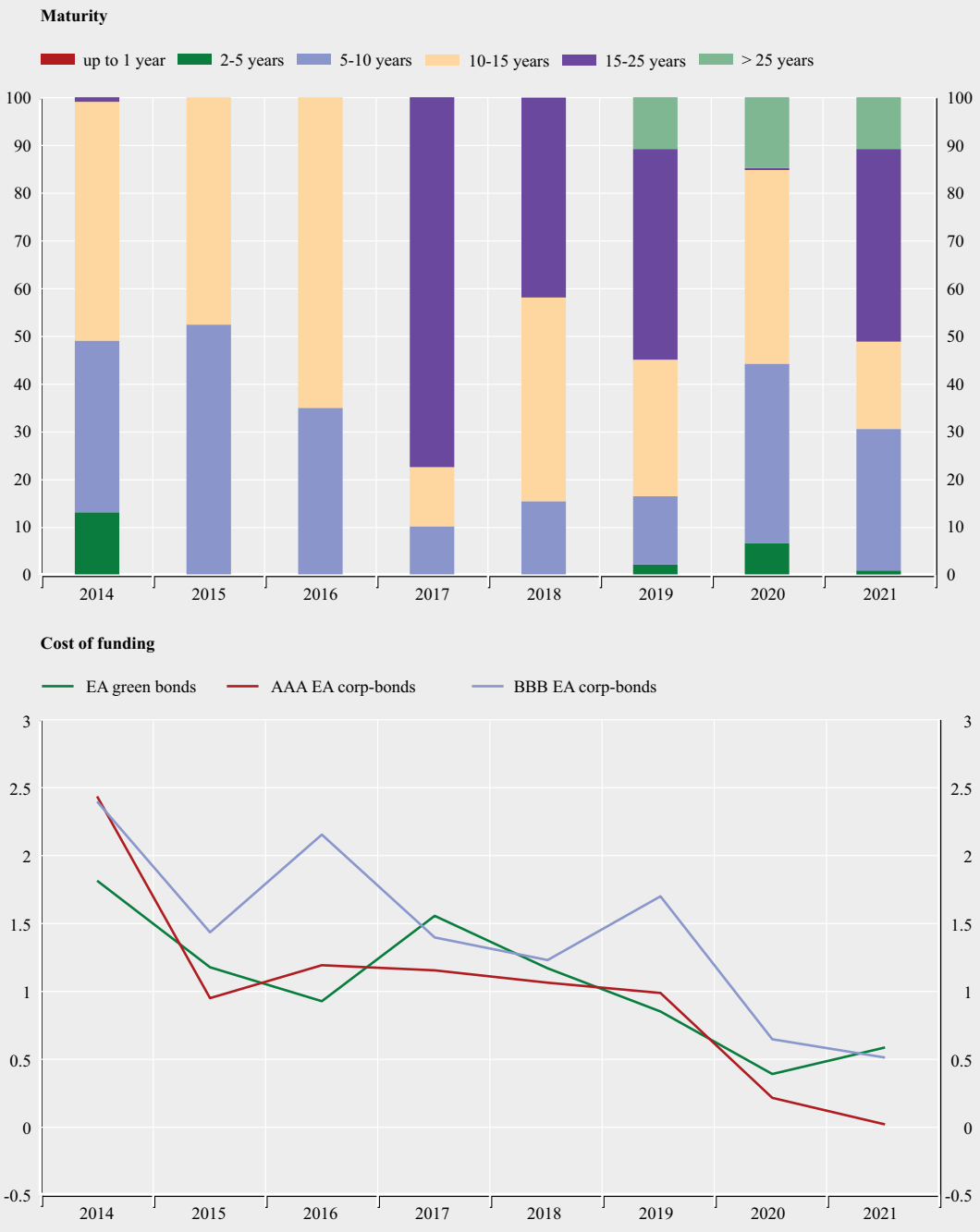
(USD billions)



Sources: Refinitiv and Bank of Greece.
Notes: The chart distinguishes the bond issues presented in Chart 1 into issues carried out by public- and private-sector entities residing in euro area countries (top panel), the United States (middle panel) or other countries (bottom panel). The public sector comprises the general government, as well as sub-sovereign entities, municipalities, regions or federal states, etc. The private sector includes both financial and non-financial corporations.

Chart 3 Characteristics of green bonds issued by euro area entities

(%)



Source: Refinitiv.
Notes: The top panel presents the distribution of the term to maturity at issuance of new bonds issued in the years indicated on the horizontal axis; term to maturity has been classified into maturity buckets according to standard bond market practice. The percentage rates have been calculated based on the sum of the amounts of bonds issued and falling into each maturity bucket to the total amount of green bonds issued in that year. The bottom panel presents the average coupon rate of green bonds issued by euro area entities per year, weighted by the amount at issuance (green line). This is compared with the yield of bonds issued by euro area non-financial corporations (iBoxx EA NFCs: AAA-red line and BBB-purple line).

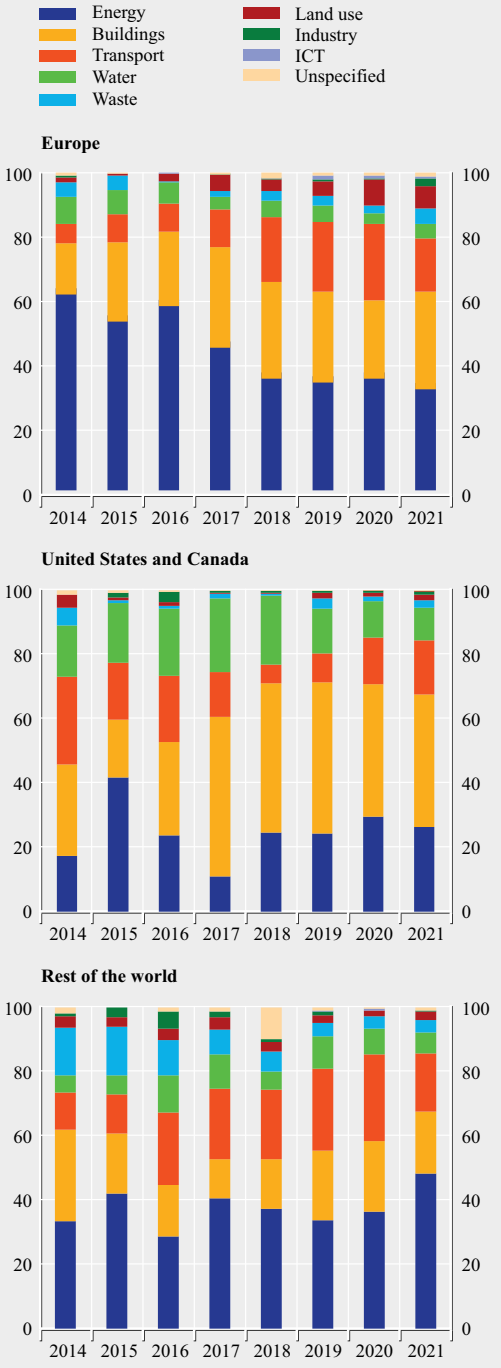
prolonged maturity of the newer bond issuances may have important economic implications, as the longer horizon provides stable funding for long-term investment plans and projects. Thus, it may provide a suitable type of long-term financing to euro area entities towards achieving their energy transition goals for the next decades.

From the bottom panel of Chart 3 it is evident that the coupon rate charged on new green and sustainable bonds issued by euro area entities is firmly lower than the yield of the BBB-rated euro area corporate bonds. This may imply that either the cost of green bond issuance is somewhat better than that of the euro area corporate bonds, on average, or that the companies that issue green bonds are of better credit quality than the average euro area corporation. At the same time, it is evident that the downward trend of the cost of funding of green bonds has been a development that cannot be isolated from the overall market conditions, as our sample only includes a period of exceptionally easy monetary and financial conditions. So, even if there are some indications that the coupon rates of green bonds have declined and that they compare to the yields of investment grade (IG) bonds, the tighter connection to the BBB category and the close association to broader market trends do not support the existence of a "greenium", i.e. a premium paid by investors to the issuing companies, in order to incentivise their transition towards greener forms of production.

According to the latest available report of the Climate Bonds Initiative for 2021, in terms of the activities funded by the issued green bonds (i.e. based on the use of proceeds model), these were mainly concentrated in the sectors of energy, buildings —around one third each— and transport —about one fifth— altogether accounting for 81% of the issuances of green bonds. In order to gauge the contribution of funding to the effort to transform the global economy towards a greener and more sustainable model, Chart 4 shows the sectoral distribution of private sector entities issuing

Chart 4 Corporate green bonds: breakdown by sector of issuer

(%)



Source: Climate Bonds Initiative.
Notes: The chart shows the distribution of green bonds issued by corporate entities according to the issuer's sector. The classifications of geographical regions and corporate sectors are those reported in the Climate Bonds Initiative database, based on the "use of proceeds" filter.

green bonds. The labelled green bonds are consistent with a framework, such as that of the Climate Bonds Initiative, and include commitments to use the proceeds of the bond issuance in activities that are aligned with certain environmental objectives. Thus, a high issuing activity in a particular sector relative to the other economic activity sectors might indicate that this sector is in the lead of investing in green activities.

As shown in Chart 4, the taxonomy of the private sector entities issuing green bonds is quite different across geographical regions. Up to 2015 when the Paris Agreement was signed, the energy sector dominated the green bond issuance activity in Europe. Since then, the construction (buildings) and transport sectors have accelerated their bond issuances and in 2021 they accounted for almost half (47%) of total green bonds issued by the European private sector. The construction sector is also the largest green bond issuing sector in the United States and Canada, while the energy sector remains the main green bond issuing sector in the rest of the world.

The above might provide evidence that in Europe green bond issuance is financing activities related, for example, to (i) the growth of greener energy technologies; (ii) the improvement of the energy-efficiency of buildings; and (iii) the development of greener forms of transportation. In other words, it seems that in the future the European economy could rely more on renewable and green forms of energy, more energy-efficient buildings and a possibly more electrified transport sector, with gradual declines in emissions in line with the targets of the European Green Deal and the "Fit for 55" package for reducing GHG emissions by 55% by 2030 compared with the 1990 level.

3 ESG CRITERIA AND CREDIT RATINGS

ESG criteria represent a significant parameter that has the potential to reward sustainable and responsible business practices. Overall, the term ESG refers to a wide range of issues related to the sustainability of an organisation and to the impact of its business, investments and activities on the environment and the society. Recent literature focuses on whether good performance on ESG indicators, which are relevant to an entity, can reduce corporate risks, generate long-term value for shareholders and improve corporate performance (see among others Eliwa et al. 2011; Goss and Roberts 2011). According to empirical findings, firms with a strong ESG profile tend to have lower idiosyncratic risks and higher risk-adjusted returns. Moreover, key parameters of the ESG criteria, such as strong institutions, seem to play an important role in sovereign borrowing costs (Capelle-Blancard et al. 2019). This is attributable to the improvement of relations among all stakeholders and the achievement of long-term goals.[19] On the other hand, there are indications in the literature that, depending on the economic activity sector, an investment which is based on ESG criteria can achieve a maximum average performance, but can also be less profitable (e.g. Auer and Schuhmacher 2016).

Given the above evidence, financial institutions, asset managers and CRAs consider ESG criteria in their assessments of investment and borrowing costs as important non-financial information (see for example Kiesel and Lücke 2019). Major CRAs have adopted principles for the incorporation of ESG credit factors into their credit rating analysis. Indicatively, some factors taken into account by CRAs when assigning credit ratings are the following: (i) carbon emissions; (ii) demographic and other social trends; and (iii) the quality of institutions of the country of residence. A number of research papers have examined the importance of incorporating non-financial information, including ESG factors, into credit ratings. Corporate governance —proxied by characteristics of board structure and internal procedures— seems to affect firms' creditworthiness (Ash-

19 See *inter alia* Heinemann et al. (2014); Lee and Faff (2009); El Ghoul et al. (2011); Eccles et al. (2014); Verheyden et al. (2016).

baugh-Skaife et al. 2006). There is a strong positive correlation between governance and sovereign/corporate credit ratings, as good governance reduces default risk, lowers agency costs and reduces information asymmetry (Bhojraj and Sengupta 2003). Furthermore, firms that perform better in terms of sustainability are often assigned higher ratings. Overall, there is a positive effect of the ESG scoring on credit ratings.[20] With regard to the impact of the different pillars of ESG scoring on credit ratings, results are mixed in the literature and there seems to be a spatial diversification.[21]

3.1 ESG RATING ASSESSMENTS

Increasing appetite for investments in sustainable financial products and the need for a better monitoring of corporate governance has led to a revision of credit rating methodologies, with a view to incorporating climate and environmental risks. In fact, the environmental pillar, the first pillar of the ESG criteria, has garnered interest from the society, the regulatory and supervisory authorities, as well as the investment community. Legal entities (governments and businesses) that manage environmental issues more effectively are considered as more resilient to long-term risks, while a government's creditworthiness is also influenced by its ability to cope with environmental risks, such as natural disasters, as well as long-term risks related to climate change.

The process for providing ESG data and ratings could by summarised as follows: entities disclose ESG qualitative and quantitative data and information to the public. These may be mandatory (e.g. under the Non-Financial Reporting Directive in the EU[22]) and/or voluntary disclosures (such as disclosures under the UN Principles for Responsible Investment – PRI) and sometimes they are reviewed by an independent party. Data are usually backward-looking but might also include some forward-looking aspects, such as targets for emissions reductions. Data providers collect, analyse and clean data. The ESG data might be supplemented by additional data, for example media reports, other relevant data collected via machine learning and artificial intelligence techniques, third-party data, as well as information obtained from exchanges with entities being assessed. The data may undergo some quality assurance review before sold to rating providers and/or end users. Codes of conduct are typically in place to limit the risk of conflict of interest.

As for the ESG ratings, rating providers typically establish a methodology under which a set of relevant ESG issues is identified for the entity or the instrument being assessed, and some indicators —like Key Performance Indicators— are defined to be used for evaluation. A weighting and scoring process is developed then, in order to perform the assessment. ESG issues are given a weight to reflect their importance on the final rating. A score may be assigned as a grade or point, using qualitative and/or quantitative metrics. ESG ratings may be provided as an entity's score relative to its peer group and/or as an absolute score. Overall, ESG rating providers follow diverse practices, whereby ESG ratings may cover criteria across all or some of the ESG pillars and may be largely distinguished between ratings assessing the exposure to ESG risks and the relevant risk management practices and those assessing the impact of an entity on ESG factors. Providers may review their methodologies and update their ESG ratings annually, or more frequently for some of them.

ESG criteria are integrated into credit ratings, according to the methodology applied by CRAs; essentially, the governance parameters are included directly in the quantitative stage, while environmental and social factors may be

20 For instance, regarding the relationship between ESG measurements and S&P credit ratings in the long term, see Attig et al. (2013) and Cubas-Díaz and Martínez Sedano (2018). It is worth noting, however, that the effect of ESG scores on Moody's credit ratings seems to be small; see Kiesel and Lücke (2019).

21 Both environmental and social scorings seem to have an impact on firms' credit standing in North America, while for firms in Europe this applies only to social scoring. See Dorfleitner et al. (2020).

22 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32014L0095.

taken into account as well, by quantifying their impact on the other rating variables. All three parameters are also taken into account during the qualitative assessment phase.[23] However, it should be noted that a direct and full-scale estimation of the quantitative impact of environmental criteria on scoring is an ongoing project. Environmental criteria are integrated into credit ratings mainly during the second stage, at which considerations on the rating of an entity is based on the long-term prospects and risks faced. Each entity is ranked in terms of exposure to environmental risks and the final result of the integration of environmental factors into credit rating may be either positive or negative. For instance, climate change risks negatively affect to a considerable extent states and firms heavily reliant on fossil fuels, but this is not the case for entities whose financial results rely on the production of energy from renewable energy sources. The overall effect on credit ratings in most times is negative, as concerns about the impact of the climate crisis are usually assessed as "credit weaknesses".

For sovereign debt assessments, according to the PRI, environmental factors related to sovereign debt can be grouped into four categories: (i) natural resources; (ii) physical risks; (iii) energy transition risks; and (iv) energy security. Credit rating agencies monitor environmental factors falling under the aforementioned categories. Specifically, they assess country credit risk on the basis of environmental criteria such as: GHG emissions and air quality; energy management; water resources and management; biodiversity and natural resources management; natural disasters and climate change; carbon transition; waste and pollution.

In order to extract the impact of environmental criteria on a firm, the assessment is carried out first at the economy-wide level and then at the sector level. So, besides the environmental footprint of the firm, the assessment of the environmental criteria of the firm's resident economy is also of particular importance. The process includes the scoring of the expected impact on the geographical region or regions in which the firm operates, the sector or sectors from which the largest part of the firm's income is generated, and finally the firm itself. Consequently, it is clear that the assessment of environmental criteria for the economy, which are incorporated to some degree in the credit rating of the respective sovereign entity, has some impact on firms' credit ratings as well. Moreover, sovereign credit ratings are of particular importance for the ratings of firms and financial institutions (both banks and non-banks), as they constitute a point of reference or a country ceiling, on the basis of which the other entities residing or operating in such economies are rated. It is worth noting that in the assessment of environmental criteria, equally important with the frequency of natural phenomena is their prevention and management, i.e. the adaptation measures. Respectively, issues such as the resilience of infrastructures are also considered in the score assigned to a country.

Governance indicators have stood out as the most important ESG factors in credit ratings. Integrating ESG parameters other than governance is more difficult, since so far there is no standardisation in the measurement and disclosure of climate risk-related information by entities. This highlights the importance of harmonising (i) what constitutes a robust ESG assessment and (ii) what ESG metrics and methodology to use, in order to reduce information asymmetries and gaps. At the same time, the pandemic has narrowed the focus on the social pillar, owing to the effects of the crisis on the working population and the civil society.

In terms of the market of ESG rating providers, the European Commission (2021) study on sustainability-related ratings, data and research found that at least 30 to 40 approved ESG rating providers were operating at that time in Europe. The study documented several challenges facing ESG rating providers,

23 For a more detailed analysis of the methodologies for state entities, see Malliaropulos and Migiakis (2020).

such as low transparency, problems with timeliness, accuracy and reliability, bias, conflicts of interest, and the general lack of clear and consistent terminology. This confirms previous research on metrics covering ESG criteria, e.g. Berg et al. (2022), which showed considerable heterogeneity among ESG ratings delivered by different providers. Bingler et al. (2021) studied the convergence of the assessments of firms' exposure to climate risk provided by existing metrics and found significant heterogeneity between different metrics across the sample. In a similar vein, the Aggregate Confusion Project of the MIT (Berg et al. 2022) looked into the ESG ratings from six ESG rating agencies and mapped the different methodologies, decomposing the divergence observed into contributions related to scope, measurement, and weight. The study shows that measurement accounts for 56% of the divergence, scope for 38%, and weight for 6%, with indications of possible biases during assessment, as the overall view of a firm may influence the measurement.

3.2 HOW GREEN ARE GREEN BONDS? RATINGS CAN HELP INVESTORS KNOW

Placing an increased focus on ESG criteria has become a mainstream practice for investment strategies, so that companies can showcase their improved climate risk management and environmental footprint as well as their value creation for the society. CRAs tend to reward with higher ratings entities that score higher in terms of ESG criteria. Hence, companies increasingly focus on evaluating, disclosing and managing sustainability-related risks and opportunities, and integrating ESG criteria into their decision-making process, so as to build creditworthiness and have a positive social impact. Even companies whose core business is in conflict with sustainability principles, such as fossil fuel companies, are striving to adopt sustainable business models for the benefit of the company itself, shareholders and the planet.

Thus, credit ratings are used by investors in order to form opinions about the creditworthiness of bond issuers in an economically meaningful manner and reduce information asymmetry among investors (see Pagano and Volpin 2010). They are a useful tool for making investment decisions (see among others Livingston et al. 2010; Aizenmann et al. 2013), and financial institutions, asset managers and external credit assessment institutions consider ESG factors as important non-financial information (Cash 2017; Amel-Zadeh and Serafeim 2018; Fitch Ratings 2020; S&P Global Ratings 2019). In this regard, CRAs' assessment of green bonds provides information about the quality of such bonds with respect to their creditworthiness.

ESG criteria have a large weight in credit ratings, in particular through the governance criteria. On the other hand, information provided by environmental parameters does not carry an equally important weight. So, credit ratings are not exactly calibrated to reflect environmental-specific factors of high relevance to green bonds, such as GHG emissions, waste management and physical resources management. On the other hand, rating agencies are increasingly integrating the environmental parameters during the quantitative phase of assigning credit ratings, as this phase provides the largest component of ratings, followed by a qualitative-adjustment phase.[24] Such a potential development will increase the weight of environmental factors on credit ratings.

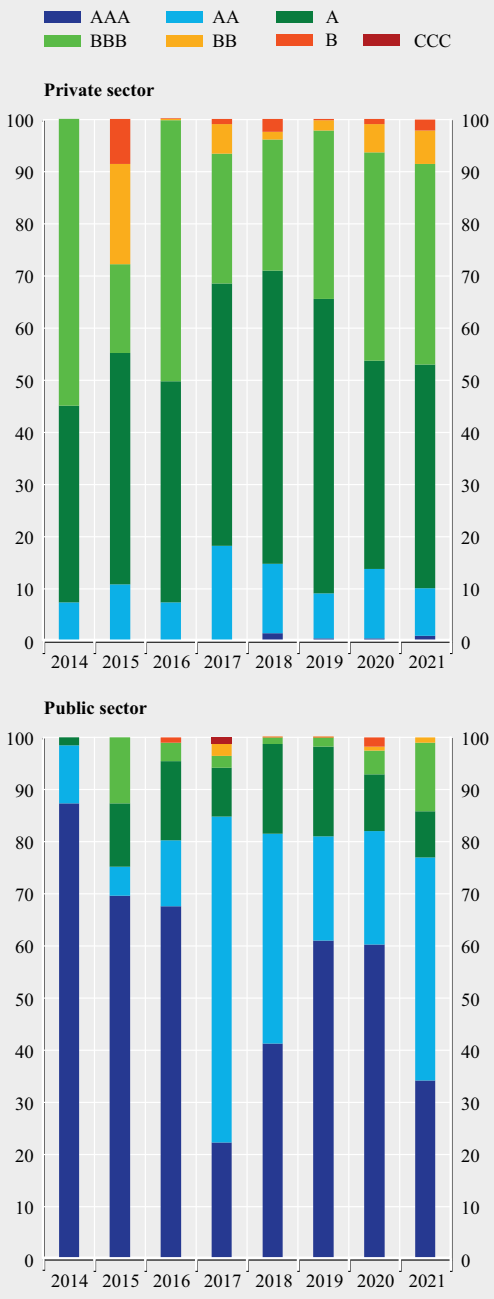
Chart 5 illustrates the distribution of green bonds issuances of the private (top panel) and the public sector (bottom panel) across rating categories.

In Chart 5 it is shown that green bonds are issued mainly by highly creditworthy issuers. In particular, around 82% of the issuers of green bonds within the public sector in the period 2014-21 are rated in the A's categories (i.e.

24 The judgmental stage, which adjusts scores derived from fundamentals, may result in a deviation of the final credit rating from the fundamentals-implied rating (see among others Lennkh and Moshammer 2018). This deviation has led to critiques on the credit rating business, which has been intense especially after the financial crises (see White 2010 and Fulghieri et al. 2013).

Chart 5 Breakdown of green bonds by credit rating

(%)



Sources: Refinitiv and Bank of Greece.
Notes: The chart provides a breakdown of private and public sector green bonds by credit rating category. The date axis denotes the year of green bond issuance. Ratings correspond to the long-term issuer credit ratings assigned by Fitch, Moody's and S&P as of 31.12.2021. The average rating is calculated by weighting ratings by the amount at issuance of the bonds belonging to that category vis-à-vis the total amount issued in that year.

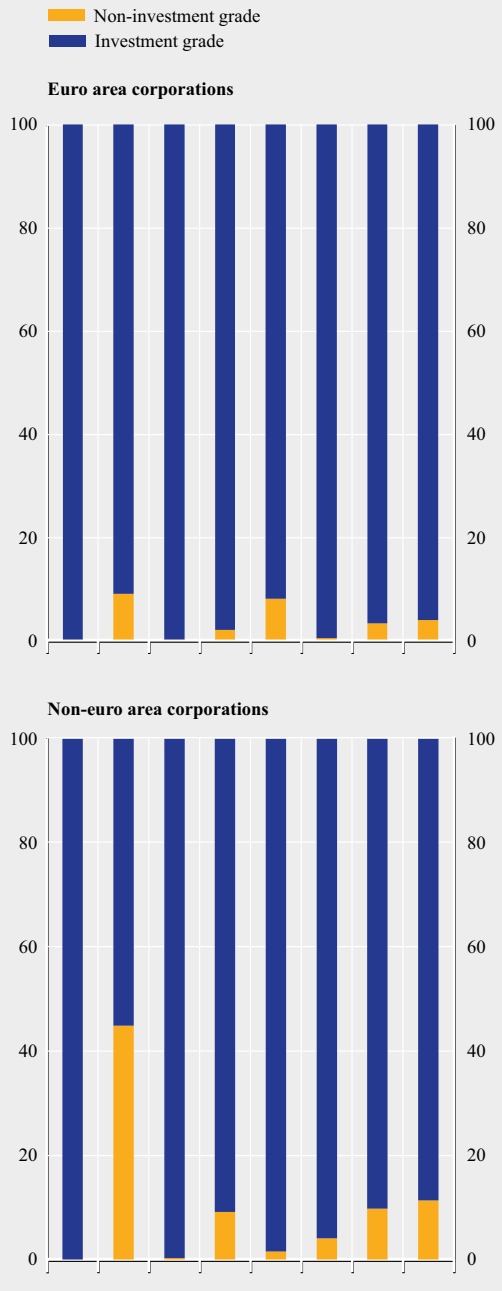
AAA, AA or A). The weighted average rating of public sector green bonds is AA-. This is a clear indication that green bonds are issued by public sector entities of high creditworthiness. The corresponding figure for green bonds issued by the private sector belonging to the A's rating categories stands at around 47% of the bonds issued by private sector entities; still, another 41% is rated above the IG threshold (which includes bonds rated at least at BBB-). Thus, the weighted average rating of private sector green bonds is between A- and BBB+. As a result, the average green bond issuer in the private sector of the economy belongs to a relatively high rating category. On the other hand, this supports the view that there is not much of a greenium in the pricing of green bonds, considering that (a) the average corporate issuer of green bonds is of a rating higher than BBB, while (b) the cost of funding from green bonds issued by these corporations compares to that from BBB-rated corporate bonds. Then at best, the market prices of green bonds are close to the average cost of the issuer's rating.

How do the ratings of green bond corporate issuers compare to those of the average corporate bond issuers? According to the rating agencies, corporate bond issuance in both the United States and Europe is done by issuers belonging to the IG category for more than 90% of total bonds issued.[25] Chart 6 provides a distribution of the credit ratings of euro area and non-euro area green bond issuers from the private sector. The chart indicates that the distribution of corporations issuing green bonds is very similar to that of corporate bond issuers in general.[26] Besides, the comparison of euro area and non-euro area bond issuers suggests that since the Paris Agreement there has been no substantial difference in the distribution of corporate green bond issuers across the two regions. Against this background, we may con-

25 See for example S&P Global Ratings, "Credit trends: Global Financial Conditions: Bond issuance looks set to contract almost 5% in 2022 as conditions tighten quickly", 27.4.2022.
26 For the broader corporate bond market, we refer interested readers to Çelik et al. (2020).

Chart 6 Corporate green bonds: ratings of euro area vis-à-vis non-euro area issuers

(%)



Sources: Refinitiv and Bank of Greece.
Notes: The chart illustrates the distribution of the amounts at issuance of green bonds issued by private sector entities across the investment-grade and the non-investment grade categories, relative to the total amounts of green bonds issued by the private sector. The top panel refers to issuers that are euro area residents and the bottom panel refers to non-euro area issuers.

clude that developments in the green bond market, both in terms of pricing and in terms of credit assessment by rating agencies, are in line with the overall market developments.

4 GOING FORWARD

To develop EU capital markets capable of coping with old and new challenges, it takes a collective effort. The green transition offers a unique opportunity to build a truly European capital market, in other words a green CMU.[27] In fact, it is a necessary step towards the completion of the Economic and Monetary Union and supports the functioning of the Banking Union. It may also support the integration of capital markets by increasing the depth and diversification of available financial instruments, while enhancing risk sharing across the EU financial system. Above all, integrated and well-functioning capital markets may facilitate capital flows towards sustainable activities.

The development of a green CMU is linked to further progress in addressing the weaknesses of the CMU, in harmonising corporate insolvency regimes and investor protection rules, as well as in strengthening the single cross-border market supervision. Timely and decisive regulatory action could help address several impediments related to the incomplete CMU, the lack of comparability and standardisation of information and financial products, and the need for a harmonised regulatory and supervisory framework for sustainable finance.

Furthermore, the improvement of the credibility, comparability and transparency of ESG ratings and assessments of CRAs is important to support sound investment decision-making and risk management, including those of central banks, which are increasingly incorporating climate change issues in their operations. From the issuers' perspective, the increasing incorporation of ESG performance in credit

27 Speech by ECB President Christine Lagarde, "Towards a green capital markets union for Europe", May 2021.

assessments can be a driver for increasing further the motivation of issuers to address sustainability issues and support the transition towards a more sustainable growth model. International collaboration and coordination of actions is also key to scale up sustainable finance at a global level and avoid fragmentation across markets and geographies.

The following two subsections include some issues, which are considered of particular importance for scaling up green finance in the EU and may support the creation of a green CMU.

4.1 THE RISK OF GREENWASHING AND EU INITIATIVES

An important element of a green CMU includes measures to enhance comparability and standardisation of information and financial products, for example through transparency standards (on which companies are required to disclose sustainability data), EU-certified green financial products (such as the proposed regulation on an EU Green Bond Standard)[28] and a harmonised regulatory and supervisory framework for sustainable finance. Indeed, the EU has taken several legislative initiatives, which are directly related to the financial system, also supporting sustainable finance through capital markets, and which can address the risk of greenwashing.[29] In particular, greenwashing is a practice which may occur when considering a product or service as one with a positive or no impact on the environment or as less damaging to the environment, when such claims are not true or cannot be verified (see for example European Commission 2021). The lack of transparency, taxonomies of sustainable activities and regulation of sustainable markets and rating providers may increase the risk of greenwashing. Greenwashing may lead among other things to misrepresentation, mislabelling, misselling and/or mispricing cases, diverting the so-needed financial resources away from investments that are aligned with the sustainability goals.[30]

The development of common standards, labels and credit rating criteria will contribute to more informed assessments and decision-making for financing and will enhance the credibility of markets. The EC's proposal for a voluntary Green Bond Standard (EUGBS) based on the EU Taxonomy is a positive step. The proposed regulation for an EUGBS includes pre- and post-issuance requirements for issuers and verification requirements from external parties. Issuers would be required to publish standardised reports with information on the environmental objectives of the bond to be issued, which need to be fully taxonomy-aligned. A registered external reviewer will validate compliance with the proposed EUGBS. Yearly reports will be published to show how proceeds are being allocated to taxonomy-aligned projects, and at least one report on the overall environmental impact of the bond will be published with post-issuance reviews required. The proposal also establishes a registration system and supervisory framework for external reviewers, managed by the European Securities and Markets Authority (ESMA).

The proposed EUGBS is voluntary. However, there are merits in making this standard mandatory —within a reasonable period of time— in order to enhance the credibility of green investments. Similar initiatives are also necessary for products that finance other aspects of sustainable development, such as other environmental objectives or social objectives, while ensuring relative flexibility in the legal framework for financial innovation. Another important aspect is the need for international collaboration and coordination of actions, in order to limit the room for regulatory arbitrage, unlevel playing fields and fragmentations across markets and geographies.

28 European green bond standard (https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/european-green-bond-standard_en).
29 For example, the Regulation on sustainability-related disclosures in the financial services sector, the (amended) Regulation on EU Climate Transition Benchmarks, EU Paris-aligned Benchmarks and sustainability-related disclosures for benchmarks, the proposed Regulation on European green bonds, and the proposal for a Corporate Sustainability Reporting Directive.
30 ESMA *Sustainable Finance Roadmap 2022-2024.*

The EC published in January 2021 a study (European Commission 2021) identifying, among others things, the lack of transparency in the methodologies of ESG rating providers, the low level of comparability between ESG ratings and potential conflicts of interests, and provided some recommendations on addressing the shortcomings. Furthermore, in the context of the EC's Strategy for Financing the Transition to a Sustainable Economy, there are actions envisaged for improving the reliability, comparability and transparency of the relevant ESG factors and the methodologies used in credit ratings, credit outlooks and ESG research. In this regard, in April 2022, the EC launched a public consultation on the functioning of the ESG ratings market in the European Union and the consideration of ESG factors in credit ratings. On the basis of the feedback from the consultation, the EC aims to perform an impact assessment, in order to assess whether a policy initiative on ESG ratings and on sustainability factors in credit ratings is necessary.[31]

Furthermore, ESMA plans to undertake several actions related to the improvement of the credibility, comparability and transparency of ESG ratings and assessments,[32] besides the publication of the guidelines for the disclosures of ESG issues in CRAs' press releases.[33] As ESMA mentioned in its letter to the EC in January 2021, there are high risks of capital misallocation, product misselling and greenwashing and there are currently no appropriate legal tools to address these risks. ESMA made some initial proposals to the EC to take action around four directions, those being: (a) the establishment of a common legal definition for an ESG rating; (b) registration and supervision of providers of ESG ratings and assessments; (c) introduction of specific product requirements for ESG ratings and assessments; and (d) organisational and conflict of interest requirements subject to proportionality considerations distinguishing larger and smaller entities.[34] ESMA also highlighted that the CRA Regulation could be an informative starting point to design the appropriate legal framework for ESG ratings and assessments. The call for evidence, which was recently launched by ESMA, may provide additional information on the market structure of ESG rating providers in the EU.[35] It is important that the regulatory interventions are completed without undue delay, in order to facilitate effective financing at the scale and speed needed to meet the ambitious targets of the transition plans.

4.2 THE ROLE OF CENTRAL BANKS

Central banks around the world are considering possible ways to incorporate the effects of climate change, whether associated with physical risks or the transition to a low-carbon economy, into their macroeconomic forecasts and financial stability monitoring. Moreover, central banks are already actively involved in integrating climate-related risks into the prudential framework and supervisory approaches, while at the same time they are in constant dialogue with credit rating agencies and financial institutions to ensure that these organisations understand climate risks, disclose them appropriately and take them into account in their overall risk assessment methodologies and lending decisions.

In this respect, the Governing Council of the ECB approved in the summer of 2021 a comprehensive action plan, which includes an ambitious roadmap, with a view to further integrating climate change considerations in its monetary policy. The ECB supports the ongoing EU initiatives to improve the disclosure of climate data, in order to enhance transparency and promote a market for green financial products. A milestone in this roadmap concerns monetary policy operations, in which climate change issues are given greater weight, in order to ensure that climate risks are properly disclosed and that securities

31 EC, Targeted consultation on the functioning of the ESG ratings market in the European Union and on the consideration of ESG factors in credit ratings.
32 ESMA, *Sustainable Finance Roadmap 2022-2024.*
33 ESMA, *Final Report, Guidelines on Disclosure Requirements Applicable to Credit Ratings*, 18.7.2019 (ESMA33-9-320).
34 ESMA letter to the EC on ESG ratings, 29.1.2021.
35 ESMA call for evidence on ESG ratings, 3.2.2022.

market transactions, and thus the balance sheet of the central bank, are greener. The plan envisages also actions on the use of credit ratings for collateral and asset purchases, namely: the assessment of rating agencies' disclosures and understanding of how these incorporate climate change risk in their ratings; the development of minimum standards for internal credit ratings; and the possibility to introduce requirements into the Eurosystem Credit Assessment Framework (ECAF)[36] targeted to climate change risk, if needed.[37] These actions highlight the importance of developing high-quality ESG data, ratings and research for managing climate-related risks and harnessing opportunities from the transition to a low-emissions economy.

4.3 GOING DIGITAL TO PROMOTE GREEN FINANCE

It has been acknowledged that green finance, which is designed to spur investment in green innovation and which can ease financing demands for long-term projects, will support the transition to a low-carbon economy, playing at the same time a role in the digital transition. The application of digital technologies in green finance is perceived as beneficial for its potential to make large amounts of data available at a lower price and at a fast pace, improving the pricing of environmental risks and opportunities, reducing search costs for information, as well as improving the measuring and tracking of sustainability criteria (see Alonso and Marqués 2019). In such a way, green fintech[38] facilitates access to sustainable finance options, unlocks new sources of finance and enables new business models.[39] For example, the use of blockchain for the automation of processes in bond issuance, although not yet widely adopted, has the potential to reduce the costs of designing and financing of green bonds. Big data, machine learning and artificial intelligence would allow data collection from disparate sources, processing of large amounts of data about companies' social and environmental footprints, as well as translation into more standardised and comparable data for investment decision-making. These digital technologies are already being used by organisations in disaster risk management.[40] Blockchain technology also allows the greenness of investments to be verified in a secure and transparent manner, increasing confidence and lowering costs associated with green labelling. Fintech solutions facilitate access to green finance for startups, e.g. through peer-to-peer (P2P) solutions. Green crowdfunding platforms enable investors to directly participate in the financial system, unlocking new sources of sustainable finance.

On the other hand, the challenges that are related with leveraging the full potential of digital finance to mobilise sustainable finance include among other things the high energy footprint of digital technologies, the weak digital infrastructure, the high costs of newer technologies, the quality and use of sustainability-related data for financial decision-making, as well as the limited awareness and understanding of sustainable digital finance.

5 CONCLUSION

The EU has been in the forefront of international efforts to fight climate change. The EC has announced the European Green Deal as a roadmap with actions to transition the EU economy to climate neutrality by 2050. To achieve the goals set by the European Green Deal, the EC has pledged to mobilise at least EUR 1 trillion in sustainable investments over the next decade, requiring an unprecedented shift in both public and private funds to finance the transition. The funds will be generated

36 Eurosystem credit assessment framework.
37 ECB's action plan to include climate change considerations in its monetary policy strategy, 8.7.2021.
38 The term "green financial technology" (green fintech) is defined as "technology-enabled innovations applied to any kind of financial processes and products all while intentionally supporting Sustainable Development Goals or reducing sustainability risks". For a green fintech taxonomy, see https://www.greenfinanceplatform.org/sites/default/files/downloads/resource/GreenFintech-TaxonomyDataLandscaping-v5%20.pdf.
39 https://g20sfwg.org/wp-content/uploads/2021/06/G20_Sustainable_Finance_Synthesis_Report_2018.pdf.
40 The World Bank uses machine learning techniques in its disaster management strategy: https://documents1.worldbank.org/curated/en/503591547666118137/pdf/133787-WorldBank-DisasterRiskManagement-Ebook-D6.pdf.

inter alia under the 2021-2027 Multiannual Financial Framework and through the NGEU instrument, with a total volume of EUR 750 billion. Even though this is a large sum, a huge gap of at least EUR 2.5 trillion remains to be financed predominantly by the private sector.[41] Therefore, the mobilisation of investment resources and the development of appropriate financial instruments are warranted.

In this respect, over the past ten years green bonds have been used in the mainstream of the international capital markets. These instruments have been shown to be critical in helping bridge the massive investment gap required to meet the targets set out in the 2015 Paris Agreement. In fact, global green bond markets have grown rapidly in recent years. Based on issue- and issuer-specific data, we find that the global market activity for financing projects within the scope of a green bond issuance has accelerated during the last years, with the aggregate amount of bonds issued in the period 2019-21 almost tripling compared with the period 2014-18. Moreover, we show that European markets and issuers lead this development, while private sector entities are increasingly making use of green bond markets as a source of funding. On the other hand, funding from green bond markets has been directed to few sectors of the economy, underlining the need for some policy-related initiatives. As argued, the increase in green bond issuance has come during a period of easy financial conditions, which could further highlight the scope for policy initiatives aimed at enhancing the provision of incentives to investors towards green financing in the present changing market landscape.

With environmental, social and governance issues growing in prominence in every sector, ESG criteria represent an increasingly significant parameter in credit ratings, and CRAs tend to reward with higher ratings entities that score higher in terms of ESG criteria. As CRAs are developing their methodologies for the incorporation of ESG credit factors into their analyses, ESG criteria may be of greater importance to credit ratings in the future. For that matter, it is also key that the necessary regulatory interventions on various fronts —including capital markets and disclosures— are completed in a timely manner, in order to facilitate financing at the scale and speed needed to meet the ambitious targets of the green transition plans.

41 https://unctad.org/press-material/developing-countries-face-25-trillion-annual-investment-gap-key-sustainable.

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WORKING PAPERS (JANUARY – JULY 2022)

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CONTENTS

Novel techniques for Bayesian inference in univariate and multivariate stochastic volatility models

Working Paper No. 294
Mike G. Tsionas

In this paper, the author exploits properties of the likelihood function of the stochastic volatility model to show that it can be approximated accurately and efficiently using a response surface methodology. The approximation is across the plausible range of parameter values and all possible data, and is found to be highly accurate. The methods extend easily to multivariate models and are applied to artificial data as well as to ten exchange rates and all stocks of FTSE100 using daily data. Formal comparisons with multivariate GARCH models are undertaken using a special prior for the GARCH parameters. The comparisons are based on marginal likelihood and the Bayes factors.

Did COVID-19 induce a reallocation wave?

Working Paper No. 295
Agostino Consolo and Filippos Petroulakis

Recent research has argued that the COVID-19 shock has also brought about a reallocation shock. The authors examine the evidence for such an occurrence in the United States, taking a broad perspective. They first consider microdata from CPS and JOLTS; there is no noticeable uptick in occupation or sector switches, nor churn, either at the aggregate level or at the cross-section level, or when broken down by firm size. They then examine whether mismatch unemployment has risen as a result of the pandemic; using an off-the-shelf multisector search and matching model, there is little evidence that mismatch has played an important role in driving the elevated unemployment rate. Finally, they employ a novel Bayesian SVAR framework with sign restrictions to identify a reallocation shock; they find that it has played a relatively minor role in explaining labour market patterns in the pandemic, at least relative to its importance in earlier episodes.

Forecasting macroeconomic indicators for eurozone and Greece: how useful are the oil price assumptions?

Working Paper No. 296
George Filis, Stavros Degiannakis and Zacharias Bragoudakis

This study evaluates oil price forecasts based on their economic significance for macroeconomic predictions. More specifically, the authors first use the current state-of-the-art frameworks to forecast monthly oil prices and subsequently they use these forecasts, as oil price assumptions, to predict eurozone and Greek inflation rates and industrial production indices. The macroeconomic predictions are generated by means of regression-based models. The study shows that when oil price forecasts are assessed on the basis of statistical loss functions, the MIDAS models, as well as the futures-based forecasts outperform those generated by the VAR and BVAR models. By contrast, it shows that in terms of their economic significance none of the oil price forecasts is capable of providing predictive gains for the eurozone core

inflation rate and the Greek industrial production index, whereas some gains are evident for the eurozone industrial production index and the Greek core inflation rate. However, in all cases the oil price forecasting models, including the random-walk, generate equal macroeconomic predictive accuracy. Thus, overall, the authors show that it is important to assess oil price forecasting frameworks based on the purpose that they are designed to serve, rather than based on their ability to predict oil prices per se.

Forecasting actuarial time series: a practical study of the effect of statistical pre-adjustments

Working Paper No. 297
Alexandros E. Milionis, Nikolaos G. Galanopoulos, Peter Hatzopoulos and Aliki Sagianou

One of the most important risks in the actuarial industry is the longevity risk. The accurate prediction of mortality rates plays a crucial role in the management of the aforementioned risk. Such predictions are performed by modelling the mortality rates using mortality models. Aiming at possible improvements in such forecasts, this work examines the effect of data transformation and "linearisation" on the quality of time series forecasts of mortality rate data. By the term time series "linearisation" is meant the treatment of causes that disrupt the underlying stochastic process measured by a time series. The dataset consists of the time series of the period indices uncovering the mortality trend for England-Wales according to published mortality models. Results indicate a clear improvement in interval forecasts. However, the result on point forecasts is not as clear as in the case of interval forecasts. The documented improvement in interval forecasts can significantly affect the Solvency Capital Requirement and subsequently the Solvency Ratio for a pension fund. Such an improvement might put some pension providers at a competitive advantage as they have less capital locked in their liabilities. In addition, it was confirmed that the transformed-linearised time series of mortality rates satisfy to a higher extent the need for normality as compared to the original series.

A functional classification analysis of government spending multipliers

Working Paper No. 298
Panagiotis Th. Konstantinou, Andromachi Partheniou and Athanasios Tagkalakis

Using a panel of 33 OECD countries, the authors estimate government spending multipliers for eleven different categories (functions) of spending: General Public Services; Defense; Public Order and Safety; Transport and Communication; Economic Services; Environment Protection; Housing and Community Amenities; Health; Education; Recreation, Culture and Religion; and Social Protection. They also account for variations in the state of the business cycle (recession versus expansion). The results suggest that Public Services, Defense, Public Order, Transport and Communication, Health, Recreation, and Education produce positive and high multipliers, whereas multipliers for Economic Services are negative and multipliers for Environment Protection, Housing and Social Protection are insignificant. In addition, multipliers for Public Services, Defense, Public Order, Transport and Communication, Health, Recreation, and Education are higher in recession than in expansion.

The effects of Federal Reserve's quantitative easing and balance sheet normalization policies on long-term interest rates

Working Paper No. 299
Sophocles N. Brissimis and Evangelia A. Georgiou

This paper develops a macro-finance term structure model based on the expectations hypothesis extended to include a time-varying term premium. The model establishes *inter alia* the link between quantitative easing and the term premium, allowing to measure the total impact on the bond yield of all phases of the Fed's unconventional monetary policy implementation, including balance sheet expansion and normalisation. Furthermore, by focusing on the long-run behaviour of the model, an estimate of the equilibrium real interest rate is derived capturing longer-run macroeconomic trends, including the Fed's, pre-financial crisis, balance-sheet trend.

The credit channel of monetary transmission in the US: is it a bank lending channel, a balance sheet channel, or both, or neither?

Working Paper No. 300
Sophocles N. Brissimis and Michalis-Panayiotis Papafilis

The authors develop a theoretical framework that extends the Bernanke and Blinder (1988) model to incorporate imperfect substitution between internal and external finance of firms, in order to study the operation of both the bank lending channel and the balance sheet channel of monetary transmission in the United States. The model is used to quantify the financial accelerator effects due to the operation of these channels. Empirically, the paper employs multivariate cointegration techniques to identify the equilibrium relationships included in the model, and provides evidence that only the balance sheet channel is operational for the period before and after the global financial crisis.

A global monetary policy factor in sovereign bond yields

Working Paper No. 301
Dimitris Malliaropulos and Petros Migiakis

This paper documents the existence of a global monetary policy factor in sovereign bond yields, which is related to the size of the aggregate balance sheet of nine major central banks of developed economies that have implemented programmes of large-scale asset purchases. Balance sheet policies of these central banks reduced the net supply of safe assets in the global economy, triggering a decline in global yields as investors rebalanced their portfolios towards more risky assets. The authors find that central banks' large-scale asset purchases have contributed to significant and permanent declines in long-term yields globally, ranging from around 330 bps for AAA-rated sovereigns to 800 bps for non-investment grade sovereigns. The stronger decline in the yields of high-risk sovereigns can be partly attributed to a decline in the foreign exchange risk premium as their currencies appreciated. Global central bank asset purchases during the COVID-19 crisis have more than counterbal-

anced the effects of expanding fiscal deficits on global bond yields, driving them to even lower levels. The findings have important policy implications: normalising monetary policy by scaling down central bank balance sheets to pre-crisis levels may lead to sharp increases in sovereign bond yields globally, widening spreads and currency depreciations of vulnerable sovereigns, with severe consequences for financial stability and the global economy.

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