SKILLS, MANAGEMENT PRACTICES AND TECHNOLOGY ADOPTION IN GREEK MANUFACTURING FIRMS

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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

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

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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.

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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

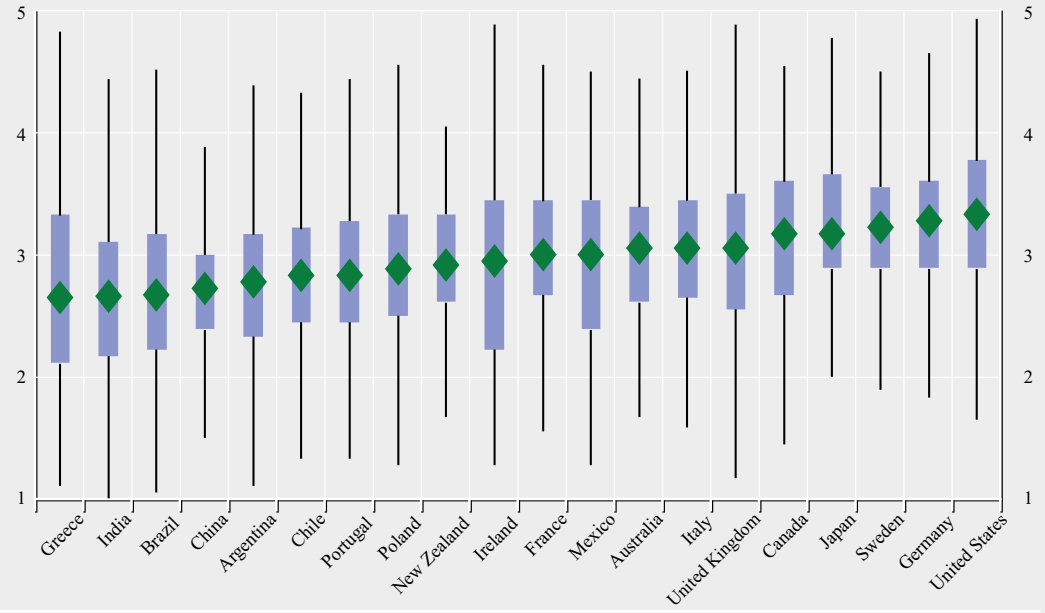
3.1 GREECE IN AN INTERNATIONAL CONTEXT

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]

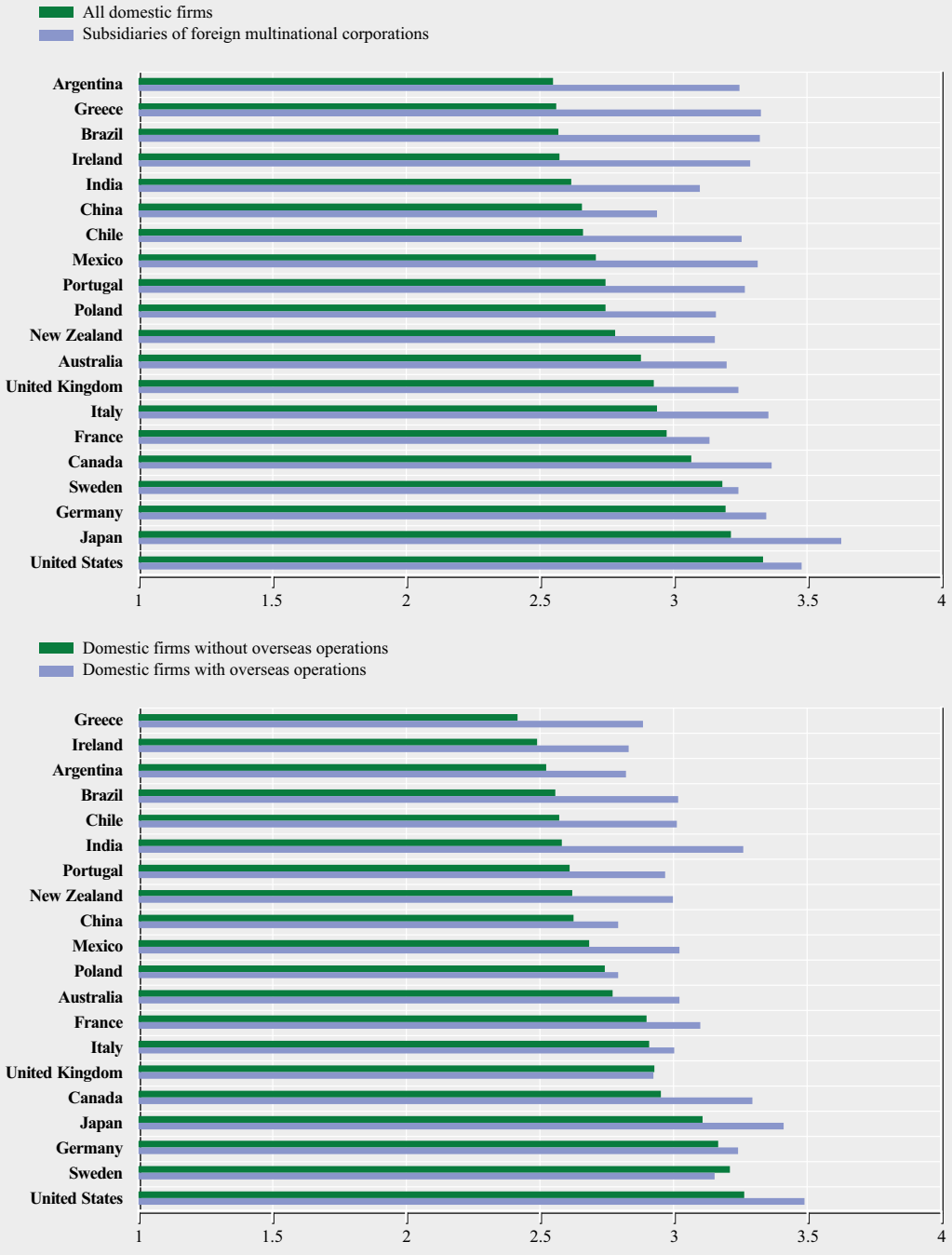
Though long ignored in the economics literature, management has risen as a key driver of growth. Bloom and Van Reenen (2007) found that higher management scores are positively and significantly associated with higher productivity and various aspects of higher firm performance. Bloom et al. (2009) further 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.

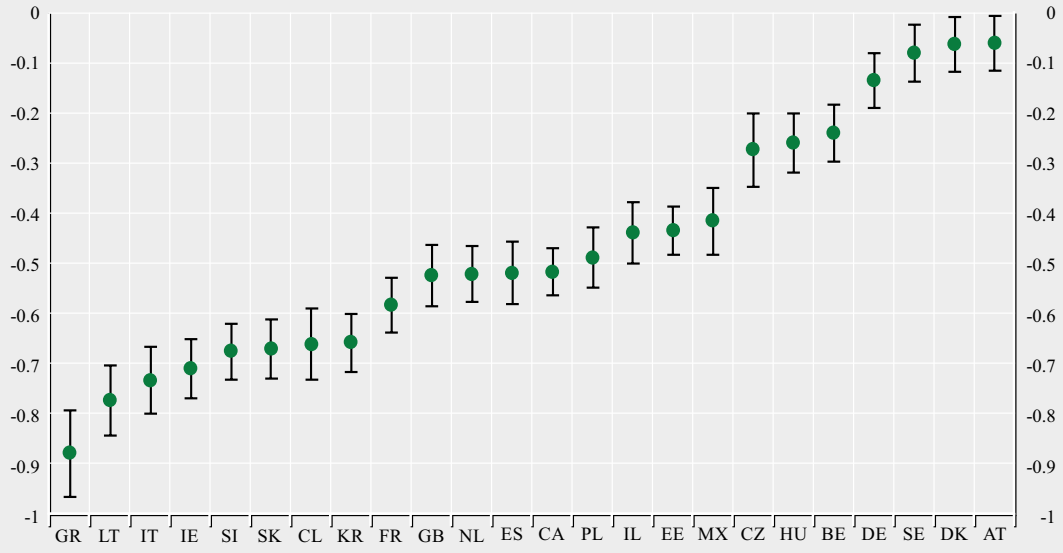
We have provided empirical evidence that Greek managers do best in issues related to decision-making, which may not require any delegation, and worst in issues requiring teamwork and cooperation, while allowing little employee autonomy relative to their peers. These findings are consistent with low levels 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.

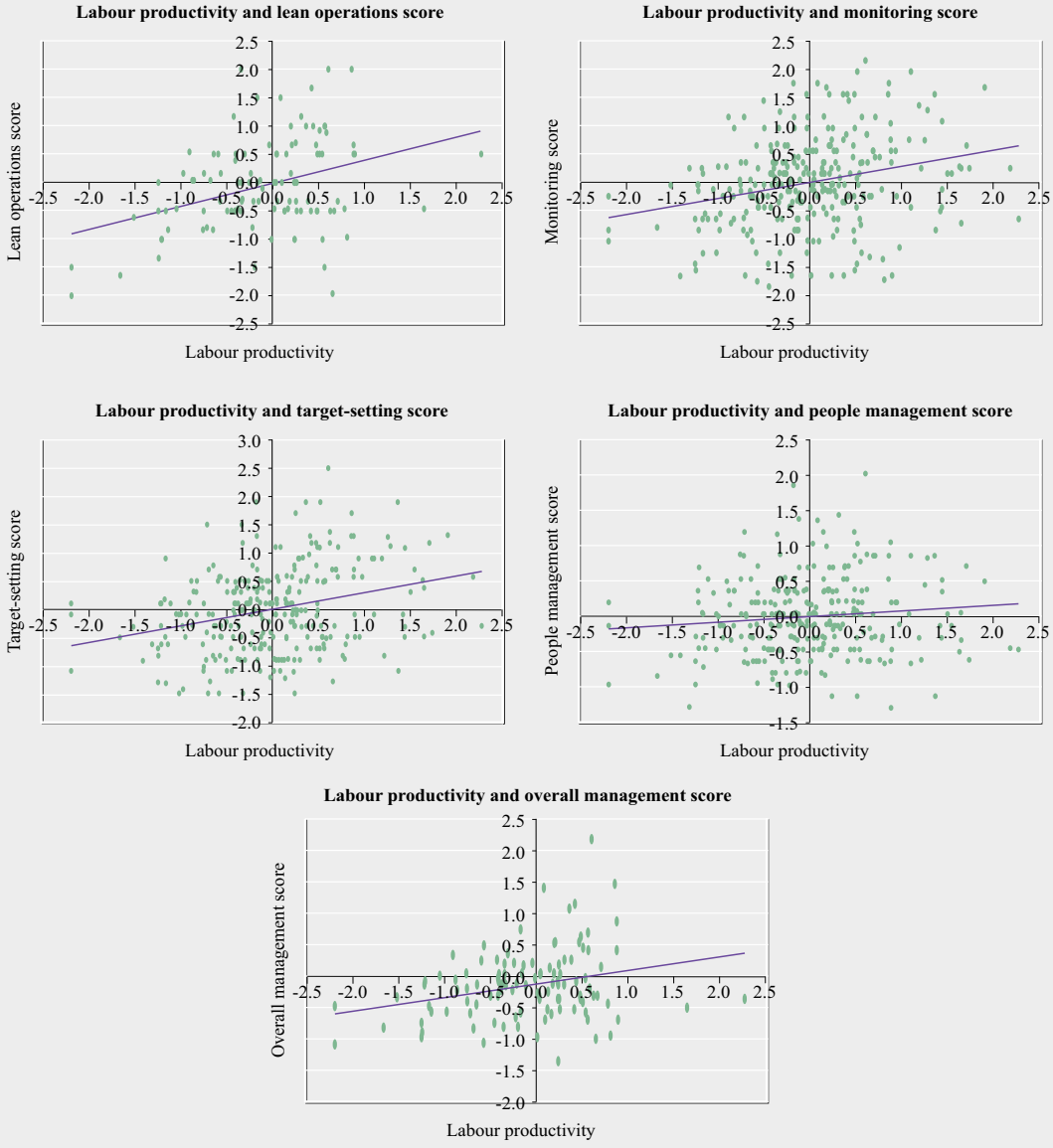
The majority of firms are in manufacturing (94.3%), with more than 40% belonging to the food, beverages and tobacco sector. More than

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;

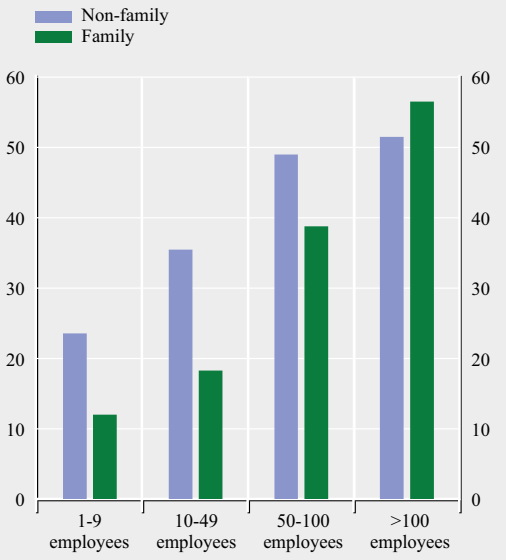
1990). Moreover, according to the European Commission's European Innovation Scoreboard, product and process innovations are areas in which Greece is classified as a strong innovator, despite being a modest innovator based on its overall innovation performance.

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)



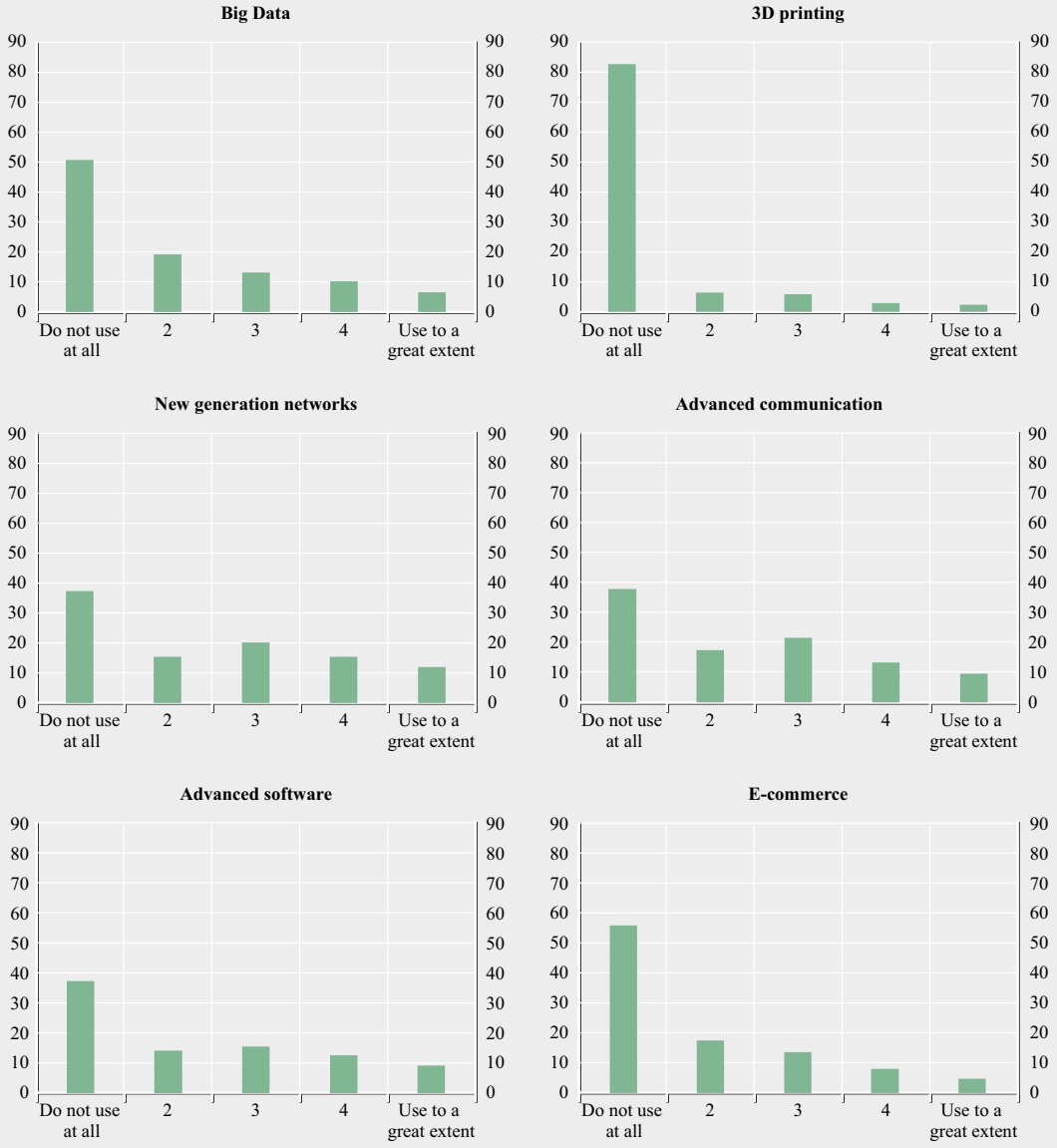
Sources: LIEE and authors' calculations.

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)

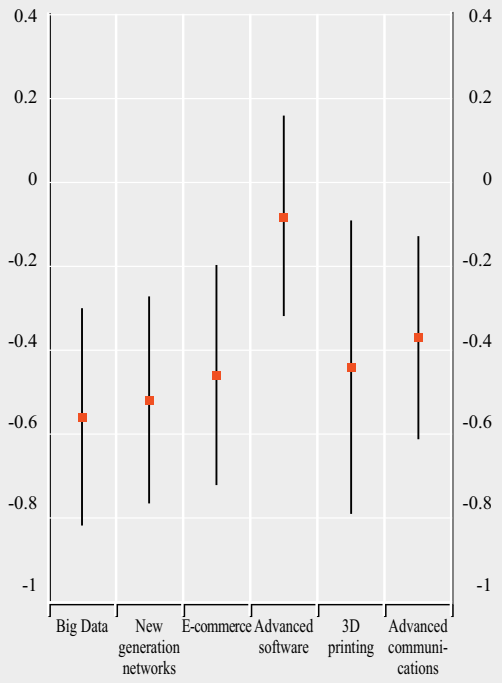


Sources: LIEE and authors' calculations.

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

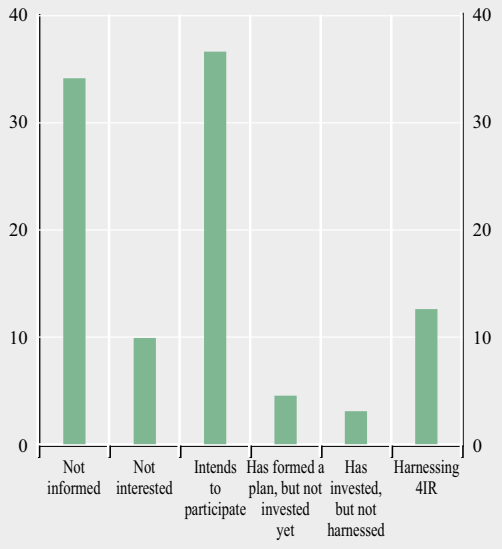
(average marginal effect)



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

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

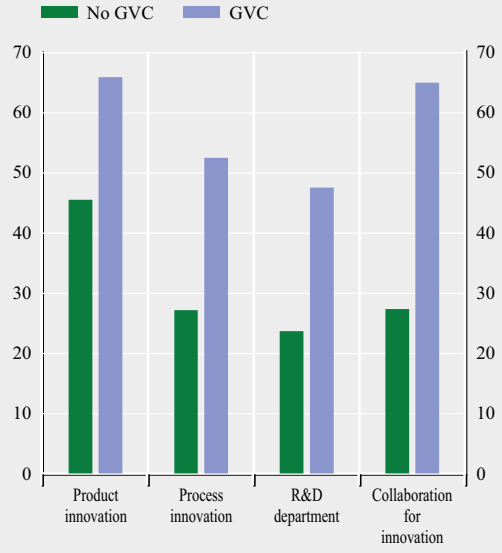
(% of respondents)



Sources: LIEE and authors' calculations.

Chart 11 GVC participation and innovation activity of Greek manufacturing firms

(% of respondents)



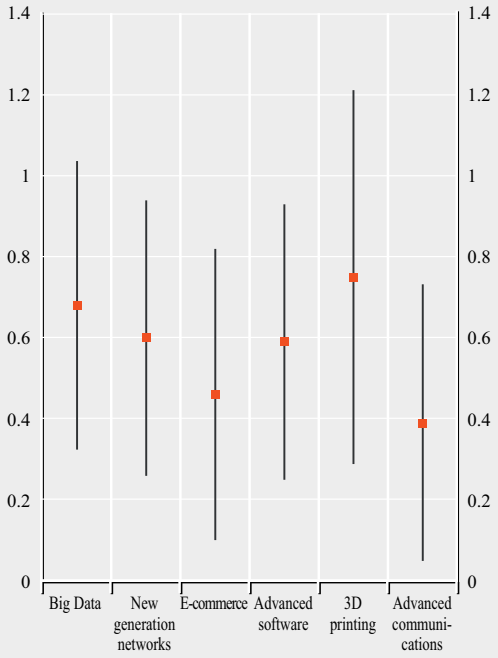
Sources: LIEE and authors' calculations.

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.

REFERENCES

Acemoglu, D. and D. Autor (2011), "Skills, tasks and technologies: Implications for employment and earnings", *Handbook of Labor Economics*, Vol. 4, Elsevier, 1043-1171.

Acemoglu, D., P. Aghion, C. Lelarge, J. Van Reenen and F. Zilibotti (2007), "Technology, information, and the decentralization of the firm", *The Quarterly Journal of Economics*, 122(4), 1759-1799.

Acs, Z.J. and D.B. Audretsch (1988), "Innovation and firm size in manufacturing", *Technovation*, 7(3), 197-210.

Acs, Z.J. and D.B. Audretsch (1990), "The determinants of small-firm growth in US manufacturing", *Applied Economics*, 22(2), 143-153.

Adalet McGowan, M. and D. Andrews (2015), "Skill mismatch and public policy in OECD countries", OECD Economics Department Working Paper No. 1210.

Aghion, P. and J. Tirole (1997), "Formal and real authority in organizations", *Journal of political economy*, 105(1), 1-29.

Aghion, P., N. Bloom, B. Lucking, R. Sadun and J. Van Reenen (2021), "Turbulence, firm decentralization, and growth in bad times", *American Economic Journal: Applied Economics*, 13(1), 133-169.

Amendolagine, V., A.F. Presbitero, R. Rabellotti and M. Sanfilippo (2019), "Local sourcing in developing countries: The role of foreign direct investments and global value chains", *World Development*, 113(C), 73-88.

Andrews, D., G. Nicoletti and C. Timiliotis (2018), "Digital technology diffusion: A matter of capabilities, incentives or both?", OECD Economics Department Working Paper No. 1476.

Antràs, P. (2020), "Conceptual aspects of global value chains", *The World Bank Economic Review*, 34(3), 551-574.

Arvanitis, S., M. Ley, F. Seliger, T. Stucki and M. Wörter (2013), "Innovationsaktivitäten in der Schweizer Wirtschaft: Eine Analyse der Ergebnisse der Innovationserhebung 2011", *KOF Studien*, 39.

Azeem, M.M. and B. Kotey (2021), "Innovation in SMEs: the role of flexible work arrangements and market competition", *The International Journal of Human Resource Management*, 1-36.

Bai, C., M. Quayson and J. Sarkis (2021), "COVID-19 pandemic digitization lessons for sustainable development of micro- and small- enterprises", *Sustainable Production and Consumption*, 27, 1989-2001.

Baldwin, R. (2016), *The Great Convergence: Information Technology and the New Globalization*, Harvard University Press.

Bartelsman, E., J. Haltiwanger and S. Scarpetta (2013), "Cross-country differences in productivity: The role of allocation and selection", *American Economic Review*, 103(1), 305-334.

Beck, M., C. Lopes-Bento and A. Schenker-Wicki (2016), "Radical or incremental: Where does R&D policy hit?", *Research Policy*, 45(4), 869-883.

Beckmann, M. (2016), "Working-time autonomy as a management practice", *IZA World of Labor*, No. 230.

Bloom, N. and J. Van Reenen (2007), "Measuring and explaining management practices across firms and countries", *The Quarterly Journal of Economics*, 122(4), 1351-1408.

Bloom, N. and J. Van Reenen (2010), "Why do management practices differ across firms and countries?", *Journal of Economic Perspectives*, 24(1), 203-224.

Bloom, N., T. Kretschmer and J. Van Reenen (2009), "Work-life balance, management practices and productivity", in: Freeman, R.B. and K.L. Shaw (eds.), *International differences in the business practices and productivity of firms*, 15-54.

Bloom, N., R. Sadun and J. Van Reenen (2012), "The organization of firms across countries", *The Quarterly Journal of Economics*, 127(4), 1663-1705.

Bloom, N., R. Sadun and J. Van Reenen (2016), "Management as a technology?", NBER Working Paper No. 22327, National Bureau of Economic Research.

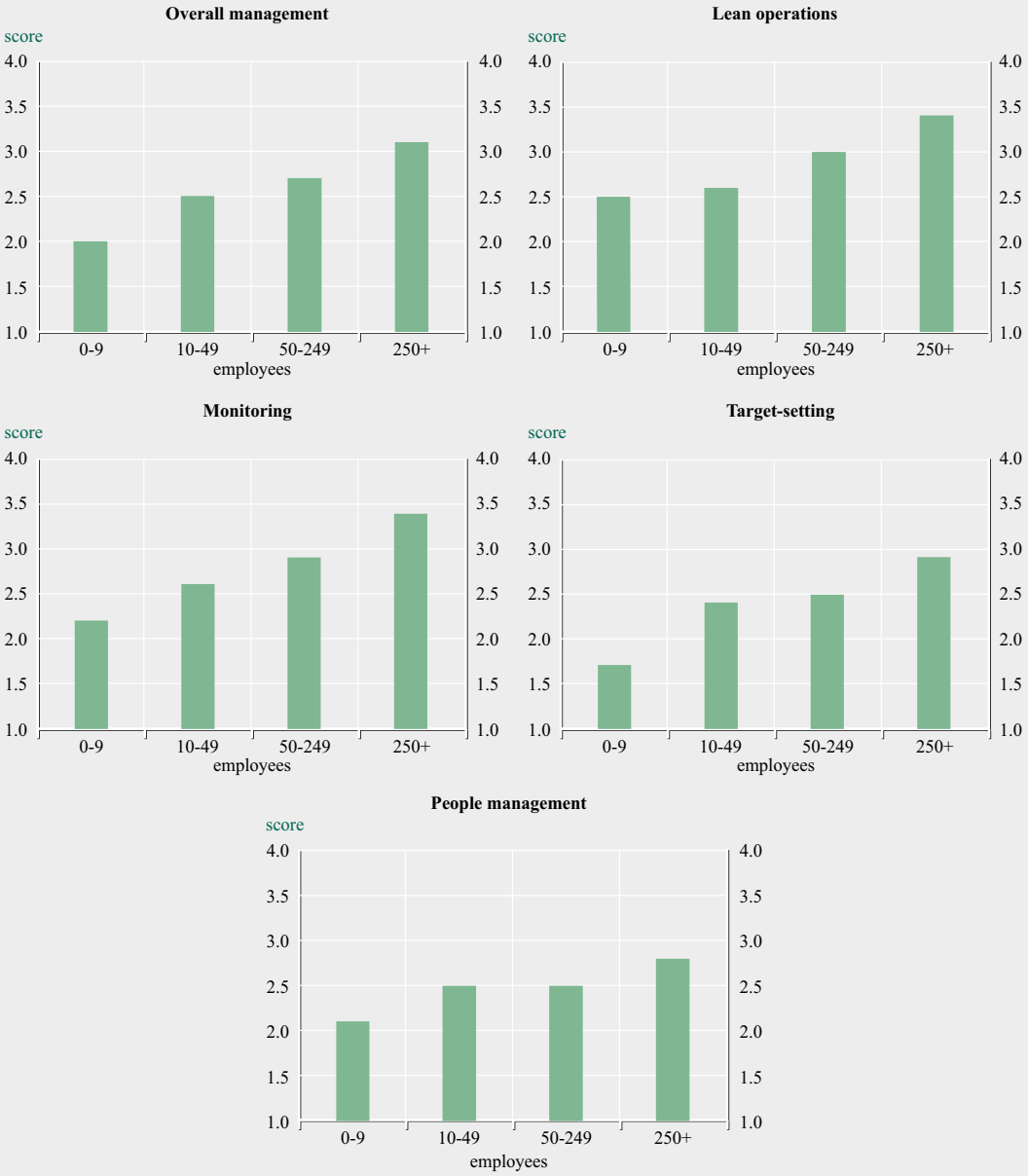
Bloom, N., C. Genakos, R. Martin and R. Sadun (2010), "Modern management: good for the environment or just hot air?", *The Economic Journal*, 120(544), 551-572.
Bloom, N., C. Genakos, R. Sadun and J. Van Reenen (2012), "Management practices across firms and countries", *Academy of Management Perspectives*, 26(1), 12-33.
Bloom, N., B. Eifert, A. Mahajan, D. McKenzie and J. Roberts (2013), "Does management matter? Evidence from India", *The Quarterly Journal of Economics*, 128(1), 1-51.
Bloom, N., E. Brynjolfsson, L. Foster, R. Jarmin, M. Patnaik, I. Saporta-Eksten and J. Van Reenen (2019), "What drives differences in management practices?", *American Economic Review*, 109(5), 1648-1683.
Bresnahan, T.F., E. Brynjolfsson and L.M. Hitt (2002), "Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence", *The Quarterly Journal of Economics*, 117(1), 339-376.
Caloghirou, Y., I. Giotopoulos, A. Kontolaimou and A. Tsakanikas (2020), "Inside the black box of high-growth firms in a crisis-hit economy: Corporate strategy, employee human capital and R&D capabilities", *International Entrepreneurship and Management Journal*, 1-27.
Carnes, C.M. and R.D. Ireland (2013), "Familiness and innovation: Resource bundling as the missing link", *Entrepreneurship Theory and Practice*, 37(6), 1399-1419.
Cedefop (2020), *Skills forecast 2020: Greece*, Cedefop skills forecast.
Coe, D. and E. Helpman (1995), "International R&D spillovers", *European Economic Review*, 39(5), 859-887.
Cohen, W.M. and R.C. Levin (1989), "Empirical studies of innovation and market structure", *Handbook of Industrial Organization*, 2, 1059-1107.
Coronado, D., M. Acosta and A. Fernández (2008), "Attitudes to innovation in peripheral economic regions", *Research Policy*, 37(6-7), 1009-1021.
Decker, R.A., J. Haltiwanger, R.S. Jarmin and J. Miranda (2017), "Declining dynamism, allocative efficiency, and the productivity slowdown", *American Economic Review*, 107(5), 322-326.
Decker, R.A., J. Haltiwanger, R.S. Jarmin and J. Miranda (2020), "Changing business dynamism and productivity: Shocks versus responsiveness", *American Economic Review*, 110(12), 3952-3990.
Deloitte and SEV (2020), *Digital Maturity study of Greek economy and Greek enterprises, SEV Digital Transformation Observatory Special Report* (in Greek).
De Massis, A., F. Frattini and U. Lichtenthaler (2013), "Research on technological innovation in family firms: present debates and future directions", *Family Business Review*, 26(1), 10-31.
Deming, D.J. (2017), "The growing importance of social skills in the labor market", *The Quarterly Journal of Economics*, 132(4), 1593-1640.
diaNEOsis/Laboratory of Industrial and Energy Economics (LIEE) at NTUA (2021), *Η Ελλάδα που Μαθαίνει, Ερευνά, Καινοτομεί και Επιχειρεί. Μια Ενοποιημένη Συστημική Στρατηγική με Επίκεντρο την Καινοτομία και τη Γνώση και ένα Πλαίσιο για την Υλοποίησή της. Γιατί είναι αναγκαία, τι περιλαμβάνει, πώς υλοποιείται, με ποιους θα προωθηθεί;* (in Greek).
Dufour, J. and P.-E. Son (2015), "Open innovation in SMEs – Towards formalization of openness", *Journal of Innovation Management*, 3(3), 90-117.
Erhel, C., M. Guergoat-Larivière and M. Mofakhami (2021), "Working time arrangements, innovation and job satisfaction: a workplace level analysis for France", CEET Working Paper No. 204.
European Commission, Executive Agency for Small and Medium-sized Enterprises (2019), *Digital transformation scoreboard 2018: EU businesses go digital: opportunities, outcomes and uptake*, Publications Office, https://data.europa.eu/doi/10.2826/691861.
European Commission (2020), *Education and Training Monitor 2020 – Greece*.
European Commission (2021), European Innovation Scoreboard.

Fjellström, M. and P. Kristmansson (2019), "Constituting an apprenticeship curriculum", *Journal of Curriculum Studies*, 51(4), 567-581.
Fons-Rosen, C., S. Kalemli-Ozcan, B. Sorensen, C. Villegas-Sanchez and V. Volosovych (2017), "Foreign investment and domestic productivity: identifying knowledge spillovers and competition effects", NBER Working Paper No. 23643.
Gartzou-Katsouyanni, K. (2021), "Cooperation against the odds: A study on the political economy of local development in a country with small firms and small farms", PhD thesis, London School of Economics and Political Science.
Genakos, C. (2018), "The tale of the two Greeces: Some management practice lessons", *Managerial and Decision Economics*, 39(8), 888-896.
Gereffi, G., J. Humphrey and T. Sturgeon (2005), "The governance of global value chains", *Review of International Political Economy*, 12(1), 78-104.
Giannetti, C. and M. Madia (2013), "Work arrangements and firm innovation: is there any relationship?", *Cambridge Journal of Economics*, 37(2), 273-297.
Godart, O.N., H. Görg and A. Hanley (2017), "Trust-based work time and innovation: Evidence from firm-level data", *ILR Review*, 70(4), 894-918.
Gorodnichenko, Y., D. Revoltella, J. Svejnar and C. Weiss (2018), "Resource misallocation in European firms: the role of constraints, firm characteristics and managerial decisions", NBER Working Paper No. 24444.
Granstrand, O. (2000), "Corporate innovation systems: a comparative study of multi-technology corporations in Japan, Sweden and the USA", paper submitted to the DynaCom Project.
Grundke, R., L. Marcolin, L.B. Nguyen and M. Squicciarini (2018), "Which skills for the digital era? Returns to skills analysis", OECD Science, Technology and Industry Working Paper No. 2018/09.
Guiso, L., P. Sapienza and L. Zingales (2006), "Does culture affect economic outcomes?", *Journal of Economic Perspectives*, 20(2), 23-48.
Hall, B.H., F. Lotti and J. Mairesse (2009), "Innovation and productivity in SMEs: empirical evidence for Italy", *Small Business Economics*, 33, 13-33.
Hansen, M.T. and J. Birkinshaw (2007), "The innovation value chain", *Harvard Business Review*, 85(6), 121-130.
Hsieh, C.T. and P.J. Klenow (2009), "Misallocation and manufacturing TFP in China and India", *The Quarterly Journal of Economics*, 124(4), 1403-1448.
Hsieh, C.-T., E. Hurst, C.I. Jones and P.J. Klenow (2019), "The allocation of talent and U.S. economic growth", *Econometrica*, 87(5), 1439-1474.
Katsikas, D. (2021), "Skills mismatch in the Greek labour market: Insights from a youth survey", ELIAMEP Policy Paper No. 79/2021.
Keller, W. (2021), "Knowledge spillovers, trade, and FDI", NBER Working Paper No. 28739, National Bureau of Economic Research.
Krammer, S.M. (2022), "Human resource policies and firm innovation: The moderating effects of economic and institutional context", *Technovation*, 110, 102366.
Leuven, E. and H. Oosterbeek (2011), "Overeducation and mismatch in the labor market", *Handbook of the Economics of Education*, 4, 283-326.
Malerba, F. and M. McKelvey (2020), "Knowledge-intensive innovative entrepreneurship integrating Schumpeter, evolutionary economics, and innovation systems", *Small Business Economics*, 54(2), 503-522.
Matzler, K., V. Veider, J. Hautz and C. Stadler (2015), "The impact of family ownership, management, and governance on innovation", *Journal of Product Innovation Management*, 32(3), 319-333.
McGuinness, S. (2006), "Overeducation in the labour market", *Journal of Economic Surveys*, 20(3), 387-418.

McGuinness, S. and M. Wooden (2009), "Overskilling, job insecurity, and career mobility", *Industrial Relations: a Journal of Economy and Society*, 48(2), 265-286.
OECD (2013), "How skills are used in the workplace", in *OECD Skills Outlook 2013: First Results from the Survey of Adult Skills*, OECD Publishing, Paris.
OECD (2016), *Policy brief on the future of work – Skills for a digital world.*
OECD (2019a), *Education at a Glance 2019: OECD indicators*, OECD Publishing, Paris
OECD (2019b), "Greece", in *OECD SME and Entrepreneurship Outlook 2019*, OECD Publishing, Paris.
OECD (2020a), *Education Policy Outlook: Greece.*
OECD (2020b), *Economic Surveys: Greece.*
Olley, G.S. and A. Pakes (1996), "The dynamics of productivity in the telecommunications equipment industry", *Econometrica*, 64(6), 1263-1297.
Pellegrino, B. and L. Zingales (2017), "Diagnosing the Italian disease", NBER Working Paper No. 23964.
Pissarides Committee (2020), "Growth plan for the Greek economy", report by C. Pissarides, D. Vayanos, N. Vettas and C. Meghir prepared at the request of the Greek Prime Minister Kyriakos Mitsotakis (in Greek).
Pouliakas, K. (2014), "A balancing act at times of austerity: matching the supply and demand for skills in the Greek labour market", IZA Discussion Paper No. 7915, Institute for the Study of Labor (IZA), Bonn.
Quintini, G. (2011), "Right for the job: Over-qualified or under-skilled?", OECD Social, Employment and Migration Working Paper No. 120.
Rigo, D. (2021), "Global value chains and technology transfer: new evidence from developing countries", *Review of the World Economy*, 157, 271-294.
Rogers, M. (2004), "Networks, firm size and innovation", *Small Business Economics*, 22(2), 141-153.
Schivardi, F. and T. Schmitz (2020), "The IT revolution and Southern Europe's two lost decades", *Journal of the European Economic Association*, 18(5), 2441-2486.
Scur, D., R. Sadun, J. Van Reenen, R. Lemos and N. Bloom (2021), "The World Management Survey at 18: lessons and the way forward", *Oxford Review of Economic Policy*, 37(2), 231-258.
Syverson, C. (2004), "Market structure and productivity: A concrete example", *Journal of Political Economy*, 112(6), 1181-1222.
Taglioni, D. and D. Winkler (2016), *Making Global Value Chains Work for Development.* Washington, DC: World Bank.
Tasoulis, K., A. Krepapa and M.M. Stewart (2019), "Leadership integrity and the role of human resource management in Greece: Gatekeeper or bystander?", *Thunderbird International Business Review*, 61(3), 491-503.
Vandeplas, A. and A. Thum-Thysen (2019), "Skills mismatch and productivity in the EU", European Commission, *European Economy,* Discussion Paper No. 100.

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.