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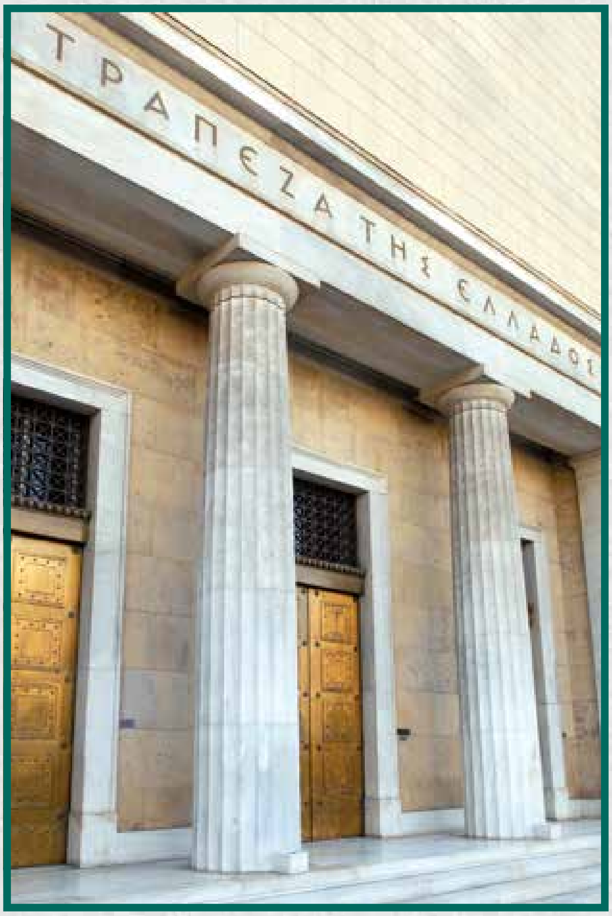

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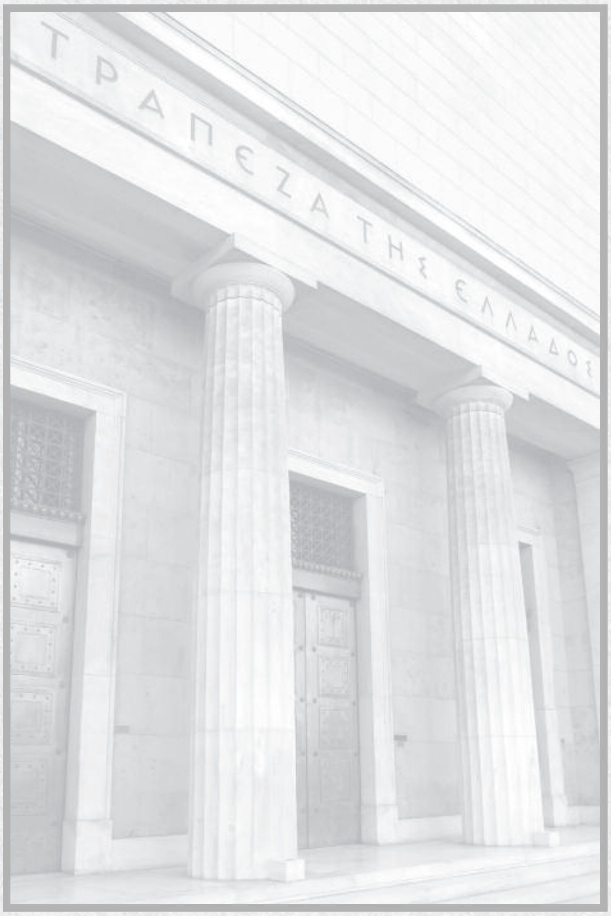

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CONTENTS

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ABSTRACT

We examine the growth rate of Total Factor Productivity (TFP) for fifteen 2-digit sectors of the Greek economy during the period 2005-2019. This measure is the sum of the rate of technical change, the rate of change in technical efficiency and the rate of change in returns to scale, that is, we have not adopted a full efficiency assumption in production. The estimations show that the vast majority of the sectors suffered negative TFP growth, primarily during the period of the economic crisis and in the first 3-4 years of implementation of the economic adjustment programmes, whereas in the subsequent years this negative rate of change slowed down. Exporting firms exhibit less negative TFP growth, likely because the production of these firms was more resistant to the pressures exerted by the crisis and, as a result, the components of TFP were less affected. Medium-sized and large firms have also recorded less negative TFP growth, which probably reflects the fact that they were better placed to respond to the fluctuations of the Greek economy, for example through higher profitability or export activity. ICT-intensive firms had a negative TFP growth rate, which was increasing in the 2006-2010 period, probably due to the unfavourable macroeconomic conditions that hampered their production. The firms that have not survived the entire 2006-2019 period had a strongly negative rate of TFP change and this most likely explains their failure to survive. In contrast, firms that have survived had, on average, a negative TFP growth rate, which was 11.1 percentage points lower than that of non-surviving firms. Finally, the results reflect a decline or small fluctuations in productivity indicators for most 1-digit sectors, since 2011 or 2012, in relation to their levels before the economic crisis.

Keywords: total factor productivity; production frontier; technical efficiency; technical change; returns to scale; value added

JEL classification: C23; D24; L11; O33

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ΤΑΣΕΙΣ ΣΤΗ ΣΥΝΟΛΙΚΗ ΠΑΡΑΓΩΓΙΚΟΤΗΤΑ ΣΤΗΝ ΕΛΛΑΔΑ ΚΑΙ ΠΡΟΣΔΙΟΡΙΣΤΙΚΟΙ ΠΑΡΑΓΟΝΤΕΣ ΑΥΤΗΣ ΤΗΝ ΠΕΡΙΟΔΟ 2005-2019

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ΠΕΡΙΛΗΨΗ

Η παρούσα μελέτη εξετάζει το ρυθμό μεταβολής της Συνολικής Παραγωγικότητας Συντελεστών (ΣΠΣ) 15 διψήφιων κλάδων της ελληνικής οικονομίας την περίοδο 2005-2019. Ο ρυθμός μεταβολής της ΣΠΣ είναι το άθροισμα των ρυθμών τεχνολογικής αλλαγής, μεταβολής της τεχνικής αποτελεσματικότητας και μεταβολής των αποδόσεων κλίμακας, δηλαδή δεν υιοθετήθηκε η υπόθεση πλήρους αποτελεσματικότητας στην παραγωγή. Οι εκτιμήσεις έδειξαν ότι η συντριπτική πλειονότητα των κλάδων της ελληνικής οικονομίας παρουσίασε αρνητικούς ρυθμούς μεταβολής της ΣΠΣ κυρίως κατά την περίοδο της οικονομικής κρίσης και τα πρώτα 3-4 χρόνια εφαρμογής των προγραμμάτων οικονομικής προσαρμογής, ενώ τα επόμενα χρόνια αυτός ο αρνητικός ρυθμός μεταβολής επιβραδύνθηκε. Οι εξαγωγικές επιχειρήσεις παρουσιάζουν χαμηλότερο αρνητικό ρυθμό μεταβολής, πιθανώς επειδή ήταν πιο ανθεκτικές στις πιέσεις που ασκήθηκαν λόγω της οικονομικής κρίσης, και ως εκ τούτου οι συνιστώσες της ΣΠΣ επηρεάστηκαν αρνητικά σε χαμηλότερο βαθμό. Οι μεσαίες και μεγάλες επιχειρήσεις παρουσιάζουν χαμηλότερο αρνητικό ρυθμό μεταβολής, αποτέλεσμα που πιθανώς αντανακλά το γεγονός ότι είχαν περισσότερους τρόπους να αντιδράσουν στις διακυμάνσεις της ελληνικής οικονομίας, όπως υψηλότερη κερδοφορία ή εξαγωγική δραστηριότητα. Οι επιχειρήσεις έντασης ΤΠΕ είχαν αρνητικό ρυθμό μεταβολής, ο οποίος έβαινε αυξανόμενος την περίοδο 2006-2010, πιθανώς λόγω των δυσμενών μακροοικονομικών συνθηκών, οι οποίες επηρέασαν αρνητικά την παραγωγή τους. Οι επιχειρήσεις που δεν επιβίωσαν ολόκληρη την περίοδο 2006-2019 είχαν έντονα αρνητικό μέσο ετήσιο ρυθμό μεταβολής και αυτό το αποτέλεσμα πιθανώς εξηγεί την αποτυχία τους. Από την άλλη πλευρά, οι επιχειρήσεις που επιβίωσαν όλη την υπό εξέταση περίοδο είχαν, κατά μέσο όρο, αρνητικό ρυθμό μεταβολής που ήταν 11,1 ποσοστιαίες μονάδες χαμηλότερος από τον αντίστοιχο ρυθμό μεταβολής των επιχειρήσεων που δεν επιβίωσαν. Τέλος, τα αποτελέσματα για τους δείκτες παραγωγικότητας για μονοψήφιους κλάδους δείχνουν πτώση ή μικρές διακυμάνσεις σε αυτούς, στους περισσότερους κλάδους, από το 2011 ή το 2012, σε σχέση με τα επίπεδά τους πριν από την οικονομική κρίση.

TRENDS IN TOTAL FACTOR PRODUCTIVITY IN GREECE AND ITS DETERMINANTS DURING THE PERIOD 2005-2019*

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1 INTRODUCTION

Despite the progress made over the last years, the Greek economy has significant weaknesses, including low intensity of competition in many product markets, a low level of productive investments, weak performance in innovation activities and inefficiencies in the education system and the public sector. Such structural weaknesses have been reflected over the years in the fiscal and the current account balances —both of which reached their historically high levels in 2009-2010— and in another key measure, total factor productivity.

These weaknesses led to the implementation of three Economic Adjustment Programmes between 2010 and 2018, which were accompanied by an unexpected weakening of overall economic activity. As a result, Greek GDP dropped significantly during the period 2008-2016 (-26.5%), except for 2014, the unemployment rate more than tripled (from 7.8% to 26.5%), and Gross Fixed Capital Formation (GFCF) declined significantly (-62.5%), which also affected the overall productivity of the Greek economy and labour productivity. However, after 2016, the Greek economy entered a growth path (GDP +1.5% on average, during the 2017-2019 period), underpinned by increased exports and household consumption. This led to lower unemployment (from 21.5% to 17.3%), while GFCF grew marginally (0.3% per year). Yet, the outbreak of the COVID-19 pandemic in 2020 drastically changed the path of the global and the Greek economy as well. Despite measures to support firms and households —due to the implementation of strict containment measures— GDP dropped significantly in Greece in 2020 (-9.0%), while GFCF marginally decreased (-0.5%) and the unemployment rate declined (from 17.3% to 16.3%) as a result of the measures taken to protect employment. However, the economy showed a strong rebound of 8.3% in 2021, unemployment further dropped to 14.7% and GFCF also increased sharply (+20.1%).

These economic trends in the overall period 2008-2021 highlight the importance of investigating the trends in Total Factor Productivity (TFP) in the Greek economy. The aim of this study is to analyse the trends and determinants of TFP, using a sample of firms of all sizes active in fifteen 2-digit sectors of the Greek economy in the period 2005-2019.

* This study was conducted by the Foundation for Economic and Industrial Research (IOBE) with the support of the Bank of Greece.

The contribution of the study to the literature is threefold. First, it is one of the very few studies that estimate TFP in the Greek economy using firm-level data. Earlier studies have mostly used either sectoral or total economy-level data (e.g. Bosworth and Kollintzas 2001; IOBE 2008; Gogos et al. 2013; Gibson 2010; Leounakis and Sakellaris 2014; Voutsinas and Tsamadias 2014; Paitaridis 2015). Second, for the estimation of TFP our study also takes into account the contribution of technical (in)efficiency to production. To the best of our knowledge, only IOBE (2008) has followed a similar approach, but with the use of sectoral data. Third, the sample used includes not only firms that have survived the whole 2005-2019 period, but also those that have exited the market (unbalanced panel data), which have also contributed to TFP.

The remainder of the study is organised as follows: the next section includes a brief literature review on the study of TFP growth for the Greek economy. In the third section, the data set used is presented, followed by a section that presents the methodology for the construction and estimation of productivity indicators for 1-digit sectors. The fifth section presents the econometric model used in the estimation of TFP for 2-digit sectors of the Greek economy, and in the sixth section the estimation results are presented and discussed. The subsequent section contains policy implications and the final one summarises the main findings of the study.

2 LITERATURE REVIEW

The literature regarding the estimation of TFP at sectoral or aggregate level is very extensive and captures a large number of developed and developing countries. The first category includes the studies of Tinbergen (1942) for Germany, the UK, France and the USA; Singh and Trieu (1999) for Japan, South Korea and Taiwan; Groth, Gutierrez-Domenech and Srinivasan (2004) for the UK; Wu (2011) for China; Berlemann and Wesselhöft (2014) for Germany; and Sheng, Ball and Nossal (2015) for Australia, Canada and the USA. The second includes the studies of Azzam and Sekkat (2005) for Morocco; Khan (2006) for Pakistan; Álvarez-Ayuso, Becerril-Torres and Moral-Barrera (2011) for Mexico; Rodríguez and Elasraag (2015) for Egypt; and Malik, Masood and Sheikh (2021) for India. At the same time, interest was directed towards other factors —apart from capital, labour and raw materials— that affect the evolution of TFP, with the use of firm- and sectoral-level data and various econometric techniques. These factors are divided into two major categories, namely firm-specific[1] and external-environment-specific.[2]

The literature has also examined the evolution of TFP in Greece for various periods. The relevant studies can be distinguished into two broad categories, those that estimate productivity in the entire economy and those that estimate productivity at the industry level.

Turning to the first category, Bosworth and Kollintzas (2001) examined TFP change during the period 1960-2000. A 4.9% increase in the period 1960-1973 was followed by a decline in 1973-1980 (-0.3%) and in 1980-1990 (-1.1%), whereas in 1990-2000 TFP increased by 0.6%. They argue that economic stagnation during the period 1973-1990 (especially after 1980) was a result of the macroeconomic policy followed, an over-regulated labour market, a deterioration in the competitiveness of tradable sectors and the provision of subsidies to inefficient firms. The increase of TFP after 1990 (especially after 1994) reflects the country's effort to implement a strict macroeconomic policy with the objective to join the Economic and Monetary Union.

1 E.g. management, human capital quality, quality of fixed capital, IT, R&D, learning-by-doing, innovation, firm structure, etc. See, for example, the studies of Bushnell and Wolfram (2009), Alvi and Ahmed (2014), Sakellaris and Wilson (2004), Bloom, Sadum and van Reenen (2012), Edquist and Henrekson (2017), Kellogg (2009), Abdih and Joutz (2005), Forbes and Lederman (2010).

2 E.g. foreign direct investment, international trade, market competition and regulation, institutions, infrastructure, degree of development of the financial system, etc. See, for example, the studies of Amann and Virmani (2015), Mayer (2001), Friesenbichler (2014), Tebaldi (2016), Khana and Sharma (2021), Kent and Simon (2007), Aghion, Howitt and Mayer-Foulkes (2005).

Gogos et al. (2013), using the methodology by Kehoe and Prescott (2002, 2007), identified that the period 1979-2001 can be characterised as a period of great depression for Greece because GDP per capita suffered a significant (-22%) and rapid deviation from its trend (-15% until 1983) and until 2001 there was no period of ten years or more in which real GDP per capita increased at an average rate equal to its trend (2%). In the next step, they employed a Cobb-Douglas production function to estimate TFP for the Greek economy and then calibrated the basic RBC model, which confirmed the findings of the production function estimation, i.e. a big decline in economic activity during the 80s and until the mid-90s, and a strong recovery in the period 1995-2001.

In addition, Leounakis and Sakellaris (2014) used annual data in order to determine the contribution of labour, capital and TFP to the growth of the Greek economy over the period 1960-2013. Their estimations showed that in the 1960-1973 period the increase in GDP by 8.08% came mainly from the increase in TFP (5.71%). In the period 1974-1979, the increase in GDP was limited to 3.38%, mainly as a result of the slower increase in TFP (1.11%), despite the increase in capital (2.33%). In the next period (1980-1993), the rate of change of GDP dropped to 0.83% as a result of the decline in TFP by 0.58%, despite the increase in labour (0.47%) and capital (0.83%). In the 1994-2007 period, GDP grew by 3.62% due to the increase in all three factors (TFP, capital, labour). Finally, in the 2008-2013 period, the economy shrank at an average annual rate of 4.37% as TFP and labour decreased by 2.44% and 2.31%, respectively. Thus, it follows from the above that the most important factor that affected the performance of the Greek economy was TFP.

Finally, Voutsinas and Tsamadias (2014) investigated the relationship between R&D and the TFP of the Greek economy over the period 1981-2007. Their results confirmed the presence of a long-run relationship between total R&D and TFP and between public R&D and TFP. However, they did not estimate a statistically significant relationship between private R&D and TFP. These results, according to the authors, are probably due to the high-quality research activity of Greek universities and their cooperation with leading innovative Greek firms.

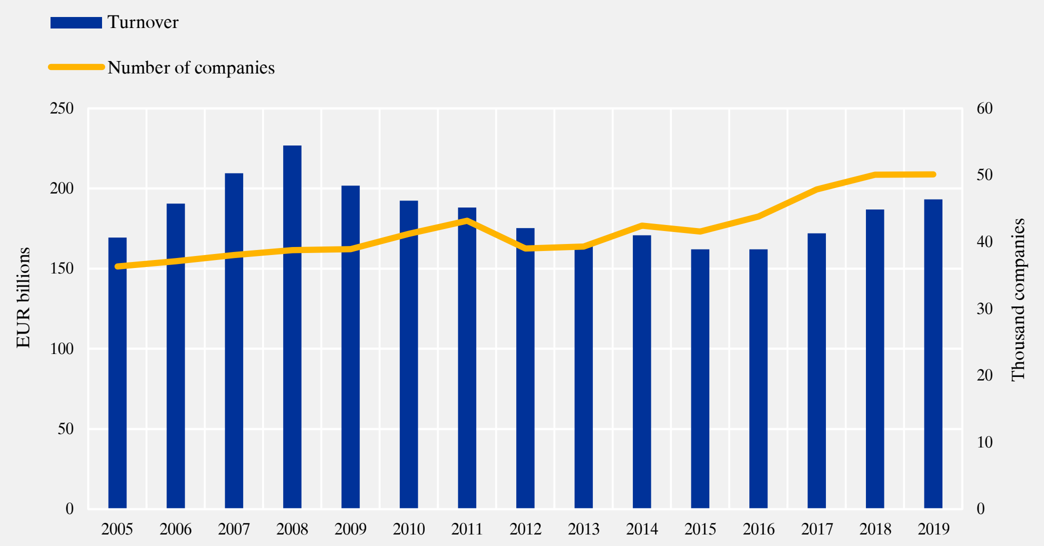
Going to the studies that estimate productivity at the industry level, IOBE (2008) analysed TFP growth and examined the role of technical efficiency, technical progress and returns to scale. Overall, the average annual growth rate of TFP during the period 1970-2004 was 1.29% but followed a downward trend. From 2.71% during the 1970s, it dropped to 1.11% in the 1980s, 0.51% in the 1990s and 0.16% in the period 2000-2004. Technological progress contributed 2.58% per year to TFP growth, but technical efficiency and scale effect slowed down the growth rate of TFP. At the sectoral level, there is a group of manufacturing sectors that performed well during the period 1970-2004 (e.g. Mining, Food-Beverages-Tobacco, Chemicals, Plastics, Metals), but most of the Service sectors suffered a reduction in TFP.

Concluding this section, Gibson (2010) studied TFP growth in ten 2-digit sectors of the Greek economy in the period 1995-2003. Estimates of a Cobb-Douglas production function showed that TFP during this period increased by almost 2%. The increase in TFP was much stronger in the non-tradable sectors, while the sectors with the highest growth and the highest TFP were Transport-Storage-Communications and Constructions. Finally, ICT-intensive sectors and sectors with a higher proportion of high-skill employees enjoyed higher TFP growth.

3 DESCRIPTION OF THE DATA SET

The data set used in the econometric estimations was drawn from the ICAP Data.prisma database and covers the period 2005-2019. ICAP collects and publishes financial data of balance sheets of Greek firms, of all legal forms. The number of firms in our sample increased significantly during the period 2005-

Chart 1 Evolution of the number of firms and turnover (2005-2019)



Sources: ICAP Data.prisma and IOBE data editing.

2019, from 36.3 thousand firms in 2005 to 50.1 in 2019, while their turnover rose from €169.4 billion to €193.1 billion, respectively (see Chart 1). One of the reasons for the increase in the number of firms was the changes in the regulatory framework regarding the preparation of financial statements. In this context, under Law 4308/2014 (Greek Accounting Standards), the preparation of financial statements became mandatory for a wider range of firms.

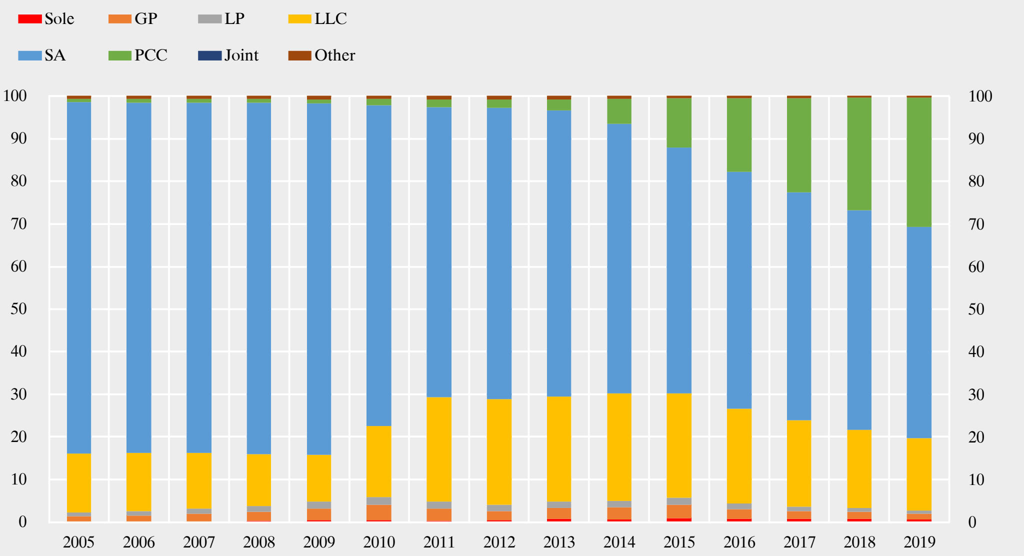
In order to check for the representativeness of the data set used in this study in terms of size (turnover) and structural characteristics, we compared it with the data set of ELSTAT's Business Register. Starting with the representativeness in terms of the turnover of the Greek economy, based on the corresponding data from the Business Register of ELSTAT, we conclude that the average percentage of coverage for the period 2005-2019 is close to 60%. Regarding the representativeness of the number of companies by turnover category (see Table A1)[3], it follows that the largest representation is observed in very large (89.3% of firms with a turnover over €50.0 million) and large firms (81.1% of firms with a turnover of between €5.0 million and €50.0 million). More than half of the firms with a turnover of between €1.5 million and €5.0 million and at least one-fourth of the firms with a turnover of between €0.5 million and €1.5 million are also included in our sample. By contrast, very small firms (turnover of between €0.0 and €500 thousand) have low representation (only 2.1%), which mainly highlights the absence of sole proprietorships from the ICAP database, because most of them are not required to prepare and publish financial statements.

With respect to the sectoral distribution of the firms in our sample, more than one-fourth of them were active in Wholesale and retail trade in 2019 (27% of firms), followed by Manufacturing (13%) and Accommodation-Food service activities (12%). Compared to 2005, the number of firms increased mainly in Real estate activities, Professional-Scientific-Technical activities, Administrative and support service activities, as well as in Human health activities. In terms of geographical distribution, more than half of the firms are located in the

3 See the Appendix for all tables.

Chart 2 Distribution of firms by legal form

(%)



Sources: ICAP Data.prisma and IOBE data editing.
Note: Sole: Sole Proprietorship, GP: General Partnership, LP: Limited Partnership, LLC: Limited Liability Company, SA: Société Anonyme, PCC: Private Capital Company, Joint: Joint Venture.

Attica region, followed by those located in Central Macedonia and Crete. The lowest percentages were recorded in the regions of Western Macedonia, North Aegean and Epirus. As far as the legal form is concerned (see Chart 2), the majority of the firms included in the ICAP database are Sociétés Anonymes (SA), followed by Limited Liability Companies (LLC). However, in the period 2014-2019, we observe a strong increase in the number (and in the share) of Private Capital Companies (PCC). Other legal forms account for a small percentage of the total number of firms, regardless of the sector considered.

4 METHODOLOGY OF CONSTRUCTION AND ESTIMATION OF PRODUCTIVITY INDICATORS FOR 1-DIGIT SECTORS

Before going to the econometric results, we present a different exercise we carried out in the context of this study, i.e. to construct and estimate productivity indicators for the 1-digit sectors of the Greek economy. Based on the existing literature, in order to construct a productivity measure with firm-level data, the following key variables are necessary: gross value added and number of employees. However, the first variable is not readily available from the financial accounts. Furthermore, another common issue when using firm-level data based on balance sheet data is the low representativeness of small firms.

First, in order to assess the representativeness of firms of different sizes, similarly to Kalemli-Ozcan et al. (2015), we examine the firm-size distribution based on employment and turnover for the ICAP and SBS/Eurostat databases in Tables A2 and A3 of the Appendix. As we would expect, the representativeness of micro firms (0-9 employed) is low in the ICAP database, compared to the SBS/Eurostat database. However, the representativeness of other size classes is not very far from that of the official statistics.

Next, we constructed a Total Factor Productivity (TFP) index as the Solow residual, following the approach of Gal (2013). First, we estimate gross value added (GVA) at factor prices as:

GVA=Compensation of Employees+EBITDA

where EBITDA (earnings before interest, taxes, depreciation and amortisation) is readily available from balance sheet data, while compensation of employees is estimated for each firm as the product of employed personnel —available in the ICAP database— and the average wage of employees for firms by size class of employment,[4] for each sector of economic activity, obtained from the SBS database or the national accounts of ELSTAT, depending on data availability.

As a preliminary step to assess the validity of the above approach, we construct the apparent labour productivity, a simple metric of productivity, using the available data from ICAP and compare it to that of the SBS database. The results presented in Chart A1 of the Appendix suggest that both the levels and the variation across time are very similar in most cases to the corresponding ones from SBS.

Then, TFP is defined for each sector of the business economy as:

$$TFP=logGVA-(1-s_L)*logK-s_L\,logL,$$

where K and L denote fixed assets and number of employees, respectively (obtained from the ICAP database), s_L represents the share of labour in value added, estimated for each economic sector using data on the cost of labour and value added from the SBS database of ELSTAT. The results obtained from this approach are presented in Chart A2 of the Appendix. From this chart we observe a decline or small fluctuations in the index in most sectors since 2011 or 2012, in relation to its levels before the Greek government debt crisis. Exceptions to this trend are the sectors of Mining-Quarrying (B), Information and Communication (J) and Administrative and support service activities (N).[5]

5 ECONOMETRIC MODEL FOR THE ESTIMATION OF TOTAL FACTOR PRODUCTIVITY GROWTH

This section presents the model used to estimate TFP growth. In the relevant literature, such an exercise is performed using a production function, where the output of a firm —usually in terms of deflated turnover or value added— is a function of capital, labour and materials. This approach adopts the full efficiency assumption, according to which no inefficiencies in production occur, that is, firms use the available inputs and the level of technology in the most effective way and produce maximum output. However, real production is usually characterised by inefficiencies, i.e. firms do not use the available inputs and the given level of technology in the most effective way and, as a result, they produce at a point below the production function. Recent developments in production economics acknowledge the existence of inefficiencies in production and, as a result, the relevant literature has highlighted the effect of not only technical efficiency, but also allocative efficiency and scale efficiency —along with the role of technical change— in production.

In this context, stochastic frontier analysis (SFA) assumes the existence of inefficiency in production. This methodology defines production technology for a given firm using a stochastic production function, where output is a function of inputs, statistical noise and technical inefficiency, which captures deviations from the frontier output. In this context, Kumbhakar and Lovell (2000), using a stochastic production frontier model, considered the estimation and decomposition of productivity not only into technical efficiency, but also into technical change, scale efficiency and allocative efficiency, an approach that numerous studies adopted thereafter (Kim and Han 2001; Liao et al. 2007; Pires and Garcia 2012; Afonso and Aubyn 2013; Saputra 2014).

4 Due to limited data availability, we used two size classes: firms with less than 10 persons employed and firms with 10 or more persons employed.
5 According to NACE Rev. 2, 1-digit classification.

However, literature has developed other alternative methods to estimate TFP, such as the methodologies of Olley and Pakes (1996), Levinsohn and Petrin (2003), Wooldridge (2009), Ackerberg, Caves and Frazer (2015). However, we do not employ one of the above methodologies in this study because the data for intermediate inputs (materials) and investments at firm level used by these methodologies are not available. One way to obtain firm-level data for intermediate inputs could be to calculate them using the formula:

Turnover = Materials + Value Added ⇔ Materials = Turnover - Value Added

Data for turnover are available from ICAP and, as mentioned above, value added was estimated in the context of this study. However, serious endogeneity issues arise using this approach because on the left-hand side of the model we have the turnover and on the right-hand side we have the materials that are obtained if we subtract the value added from the turnover. In the case of investments, their amount could be estimated by calculating the annual change in the book value of fixed assets. Yet, this approach also has problems. On the one hand, multicollinearity issues arise since the right-hand side of the model has both fixed capital and investments (which are calculated as the annual change in the book value of the fixed capital). On the other hand, in the case of a negative change in fixed capital, it is not possible to log linearise the production function, which is also the case when we have zero investments.

Taking into account the above, for the purpose of this study we assume that firm production is characterised by inefficiencies. This implies that the production function, apart from inputs, includes a technical inefficient term, as we describe below. With regard to the functional form of the production function, we employ the Translog form, which has both advantages and disadvantages. On the one hand, a Translog production function is a second-order Taylor expansion, which incorporates first-order and second-order terms across inputs and this functional form ensures the closest proximity to the actual structure of a production process, among alternative production functions. Also, it is a flexible functional form, since it imposes fewer restrictions on output elasticities and elasticities of substitution compared with other functional forms, such as the Cobb-Douglas function. On the other hand, the large number of parameters to be estimated and the difficulty in interpreting them, coupled with the fact that sometimes curvature conditions may be violated, are among the drawbacks of this functional form.

Thus, we assume that each firm of the sample produces output Y, using two inputs, capital (K) and labour (L), while the production is also affected by time trend (T). In addition, the Translog production function includes a composite error term ε that contains a two-sided "noise" component v, and a non-negative technical inefficiency component u, with ε=v-u. Thus, the Translog production function has the following form:

$$\begin{aligned} \ln Y = {} & \beta_0+\beta_L \ln L+\beta_K \ln K+\beta_T T+\frac{1}{2}\beta_{LL}(\ln L)^2 \\ & +\frac{1}{2}\beta_{KK}(\ln K)^2+\frac{1}{2}\beta_{TT}(T)^2+\beta_{LK}(\ln L)(\ln K) \\ & +\beta_{LT}(\ln L)(T)+\beta_{KT}(\ln K)(T)+\varepsilon \end{aligned}$$

The above model can be written in the following form, for firm i in period t:

$$y_{it}=\alpha+x'_{it}\beta+\varepsilon_{it} \Leftrightarrow y_{it}=\alpha+x'_{it}\beta+v_{it}-u_{it}$$

where u_{it} is a non-negative random variable that represents the technical inefficiency and follows a strictly positive distribution (e.g. Half-Normal, Exponential, Truncated Normal), with $u_{it}\geq 0$. If $u_{it}=0$, the output is produced at 100% efficiency level, thus firm i is fully efficient. If $u_{it}>0$, then output is not produced at 100% efficiency level and firm i is inefficient. Also, $v_{it}\sim N(0,\sigma_v^2)$ and captures variations in output due to exogenous shocks that are beyond the control of the firm, measurement errors and omissions of relevant variables. To estimate the above model, we use the Maximum Likelihood estimation method.

Given that we are using panel data, Pitt and Lee (1981) and Schmidt and Sickles (1984) were the first to develop technical inefficiency estimation models using panel data, by assuming that technical inefficiency is time-invariant, i.e. they made the assumption that $u_{it}=u_i$. However, this assumption is unrealistic, since in a competitive environment technical inefficiency changes over time. In another study, Battese and Coelli (1992) tried to solve the above issue by assuming that each year, each firm's technical inefficiency level is given from the formula $u_{it}=u_i\, e^{\{-\eta(t-T)\}}$, where $u_{it} \sim N^+ (\mu,\sigma_u^2)$ and η is an unknown parameter and represents the rate of inefficiency change over time. However, this approach has the disadvantage that it imposes a monotonic path of technical inefficiency for all firms, i.e. it is assumed that parameter η is the same for all producers. Thus, although the model of Battese and Coelli (1992) allows for the time variability of technical inefficiency, it does not take into account the heterogeneity that exists among firms. Not taking into account firm heterogeneity produces biased estimates of technical inefficiency. To address this issue, Greene (2005) developed a model which incorporates a random firm-specific effect w_i that takes into account the existing heterogeneity among firms. In this study we follow the same approach.

In the model used in this study, it was assumed that technical efficiency varies across firms, but remains constant through time for each firm (time-invariant technical efficiency model), and that the technical inefficiency term u_i is randomly distributed, with constant mean and variance, and it is uncorrelated with x_{it} and v_{it}, i.e. the random effects approach was applied. In addition, the sample used in the estimations includes many firms. When the number of the parameters to be estimated changes with the number of firms, the fixed effects estimator, apart from posing computational challenges, fails to satisfy the necessary statistical properties (large and small sample properties). As a consequence, the estimations are inconsistent. All the above justify both the choice of the random effects approach and the choice not to perform the Hausman test.

Taking into consideration all the above, in this study we employed Greene's (2005) model, which has the following form:

$$y_{it}=\alpha+x_{it}'\beta+w_i+v_{it}-u_{it} \Leftrightarrow y_{it}=(\alpha+w_i)+x_{it}'\beta+v_{it}-u_{it}$$

where $i=1,\ldots,n$ is the number of firms, $t=1,\ldots,T$ is the time in years (15 years, 2005-2019), y_{it} is the logarithm of production of firm i in year t, α is the constant term, w_i is a random firm-specific effect, x_{it} is the vector of the logarithm of inputs (capital and labour) of firm i in year t, β is the vector of the parameters to be estimated, v_{it} is the random error and u_{it} is the technical inefficiency component. Because the log-likelihood function of the above model has a non-closed-form integral, we use the Generalized Halton Sequence method to calculate it. In the Translog production function case, the elasticities with respect to inputs and time trend are not the values of the estimated coefficients $\hat{\beta}_L$, $\hat{\beta}_K$ and $\hat{\beta}_T$, but the partial derivatives of lnY with respect to inputs (lnK, lnL) and the time trend (T) (Greene 1997):

$$\frac{\partial \ln Y}{\partial \ln K} = \varepsilon_K = \beta_K + \beta_{KK}(\ln K) + \beta_{LK}(\ln L) + \beta_{KT}(T)$$

$$\frac{\partial \ln Y}{\partial \ln L} = \varepsilon_L = \beta_L + \beta_{LL}(\ln L) + \beta_{LK}(\ln K) + \beta_{LT}(T)$$

$$\frac{\partial \ln Y}{\partial T} = \varepsilon_T = \beta_T + \beta_{TT}(T) + \beta_{LT}(\ln L) + \beta_{KT}(\ln K)$$

In addition, technical inefficiency at firm level is estimated using the mean of the conditional distribution

$$E(u_{it}/\varepsilon_{it}) = \tilde{\mu}_i + \tilde{\sigma}_i * \left\{\frac{\varphi\left(-\frac{\tilde{\mu}_i}{\tilde{\sigma}_i}\right)}{1-\Phi\left(-\frac{\tilde{\mu}_i}{\tilde{\sigma}_i}\right)}\right\}.$$

According to Kumbhakar and Knox Lovell (2000), the rate of change in TFP is given from the following formula:

$$\dot{TFP}=TP+\Delta TE+(RTS-1)* \left[\frac{\varepsilon_K}{RTS} * \Delta \ln K+\frac{\varepsilon_L}{RTS} * \Delta \ln L\right]$$

where TP is the rate of technical change, which is given from ε_T and shows how the level of technology used changes over time, ΔTE is the rate of change of technical inefficiency with $\Delta TE=-\frac{\theta u}{\theta t}$ and shows how the level of technical inefficiency changes over time. Technical efficiency refers to the ability of a firm to produce maximum output from a given input vector and the level of technology. A drop in technical inefficiency implies an improvement in technical efficiency, and vice versa.

$(RTS\text{-}1)*\left[\frac{\varepsilon_K}{RTS}*\Delta lnK+\frac{\varepsilon_L}{RTS}*\Delta lnL\right]$ is the scale component where $RTS=\varepsilon_K+\varepsilon_L$, ΔlnK is the rate of change of fixed capital and ΔlnL is the rate of change of labour. Under constant returns to scale, input growth or contraction makes no contribution to productivity change. Non constant returns to scale make a positive contribution to productivity change if (i) we have increasing returns to scale ($RTS>1$) and input use expands $\left[\frac{\varepsilon_K}{RTS}*\Delta lnK+\frac{\varepsilon_L}{RTS}*\Delta lnL>0\right]$ or (ii) we have decreasing returns to scale ($RTS<1$) and input use contracts $\left[\frac{\varepsilon_K}{RTS}*\Delta lnK+\frac{\varepsilon_L}{RTS}*\Delta lnL<0\right]$.

From the above it is obvious that the rate of change of TFP ($\dot{TFP}$) is the sum of the technical change component (TP), the technical inefficiency change component (ΔTE) and the rate of change of the scale component $(RTS\text{-}1)*\left[\frac{\varepsilon_K}{RTS}*\Delta lnK+\frac{\varepsilon_L}{RTS}*\Delta lnL\right]$. We should stress here that it was not possible to estimate the effect of allocative efficiency, because this would require the existence of firm-level data for input prices that, to the best of our knowledge, are not available.

Finally, we should note that we estimate TFP growth on an annual basis rather than over a period of time (e.g. 5 years, 10 years or for the whole 2005-2019 period). With this approach, we have a better picture of the rate of TFP change during the 2005-2019 period, when GDP recorded strong fluctuations. For this purpose, we calculated the annual growth rate of TFP and its components.

6 ECONOMETRIC RESULTS

Before presenting the estimation results, we should note that the total sample used in this study includes firms that survived the whole 2005-2019 period, but also firms that exited/entered the market during this period (panel data). To perform estimations, turnover and fixed capital were first deflated in order to express them at constant prices (2015=100). Turnover was deflated with the use of the respective producer price indices and when such a deflator did not exist, we used the GDP deflator. Nominal fixed capital was adjusted into homogeneous real terms by means of the real cost of capital,[6] with the use of the formula

$$\frac{(1+\text{nominal interest rate})}{(1+\text{inflation rate})}.$$

The estimates presented below relate to fifteen 2-digit sectors of the Greek economy (NACE Rev. 2). The selection of these sectors was based on the statistical significance of the results, the number of observations and the importance of each sector for the Greek economy (in terms of output and/or employment). Based on these criteria, the sectors selected are the following: Manufacture of food products (10), Manufacture of chemicals and chemical products (20), Manufacture of rubber and plastic products (22), Manufacture of other non-metallic mineral products (23), Manufacture of fabricated metal products, except machinery and equipment (25), Construction of buildings (41), Wholesale and retail trade and repair of motor vehicles and motorcycles (45), Retail trade, except of motor vehicles and motorcycles (47), Warehousing and support activities for transportation (52), Accommodation (55), Food and beverage service activities (56), Computer programming, consultancy and related activities (62), Real estate activities (68), Architectural and engineering activities; technical testing and analysis (71), Human health activities (86).

With respect to the distribution that the technical inefficiency term u_{it} follows, estimations showed that exponential distribution per-

6 The real cost of capital is given from the formula $(1+r)=(1+i)/(1+\pi)$, where r is the real interest rate, i is the nominal interest rate and π is the inflation rate.

forms better. In each estimation a Wald test for the joint statistical significance of the results was performed. We also tested whether the Translog functional form is the appropriate form of the production function ($\beta_T=\beta_{LK}=\beta_{LT}=\beta_{KT}=\beta_{LL}=\beta_{KK}=\beta_{TT}=0$) and whether technological change over time exists ($\beta_T=\beta_{LT}=\beta_{KT}=\beta_{TT}=0$).

6.1 ESTIMATIONS WITH THE INITIAL DATA SET

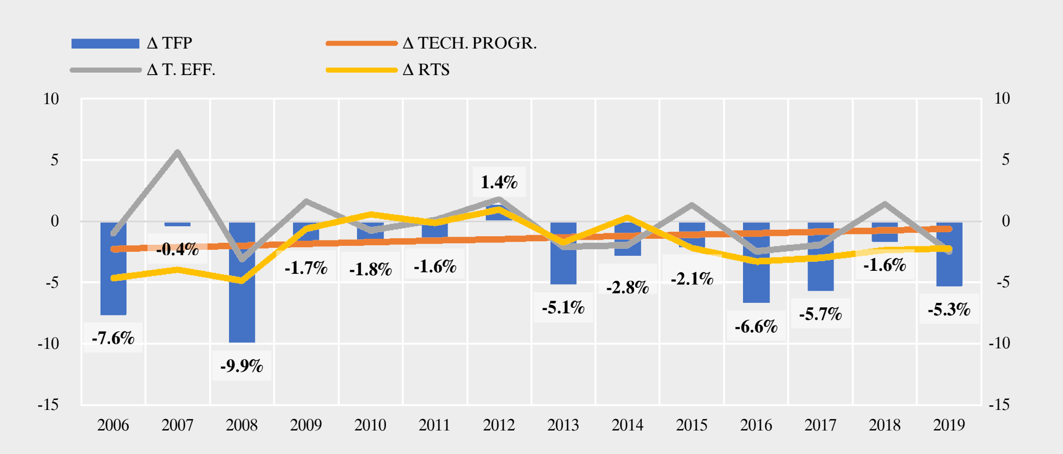
Starting with the first sector (Manufacture of food products – 10), the estimation results are jointly statistically significant at the 1% level (Wald χ^2=8,741.69 and Prob> χ^2=0.0000). Also, the Translog form is the appropriate functional form of the production function (χ^2=790.56 and Prob> χ^2=0.0000) and there is also technical progress (χ^2=26.49 and Prob> χ^2=0.0000).[7] Turning to the evolution of TFP change (see Chart 3), it recorded negative values throughout the 2005-2019 period, except 2012 (+1.4%). This negative rate was stronger in the first year of the economic crisis (2008), then dropped (2009-2012) and again increased after 2012. Technical efficiency had a positive rate of change during the first years of the economic crisis, as well as during the year of the imposition of a bank holiday and capital controls (2007, 2009, 2011, 2012, 2015, 2018). Technical change had a negative —but declining— rate of change throughout the period under review and returns to scale had a positive rate of change only in 2010, 2012 and 2014. TFP growth during the period 2005-2019 is mainly determined by the change in returns to scale because in 7 out of 14 years it is the component with the strongest contribution to the change in TFP (more than half of the change in TFP).

Going to the Manufacture of chemicals and chemical products (20), TFP (see Chart 4) had a positive rate of change in the years before the economic crisis (2006, 2007), in 2014 and in 2016, mainly due to the improvement in technical efficiency (+14.5%, +7.7%, +0.6% and +4.5 %, respectively), while in the remaining years it followed a negative trend, which was stronger during the period of the economic crisis and the first Economic Adjustment Programme (-3.3% on average in 2008-2013). The rate of change of technical progress, although negative —but declining — during the period 2006-2015, turned positive after 2015, which probably reflects the adoption of new technologies by the sector. Scale economies had a

7 Estimations of the production frontier for all examined sectors are presented in the Appendix, Table A4. We do not report the results of specification tests in the following sectors due to space limitation reasons. We will only report possible statistically insignificant results for these tests.

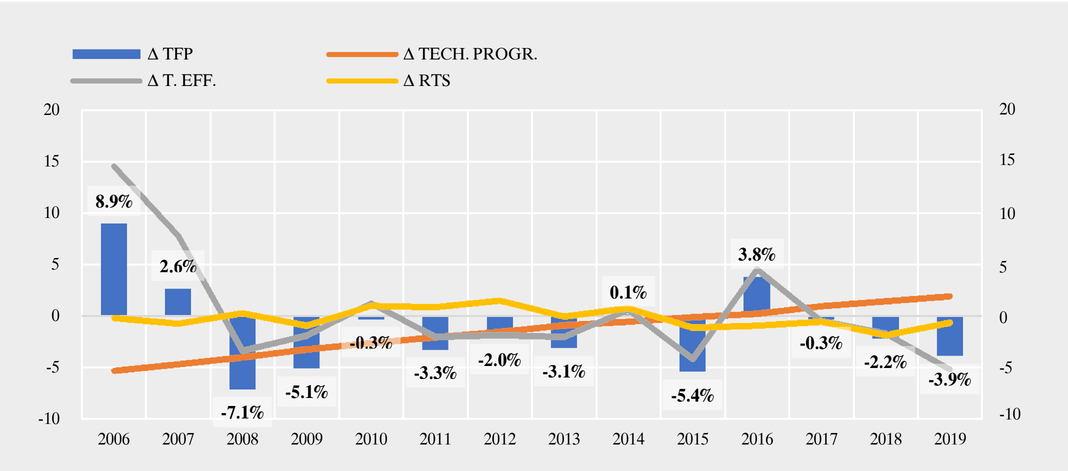
Chart 3 Growth rate of TFP and its components in the Manufacture of food products

(%)



Source: IOBE estimations.

Chart 4 Growth rate of TFP and its components in the Manufacture of chemicals and chemical products

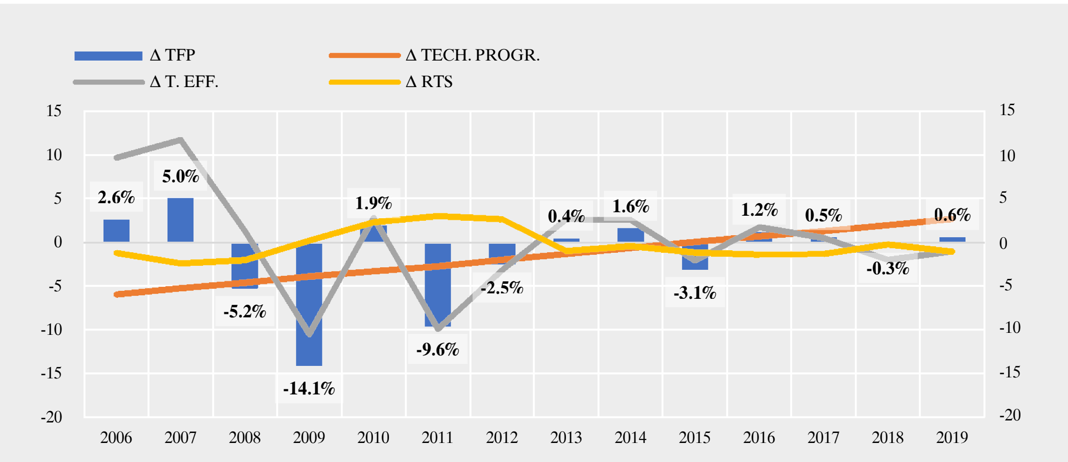


Source: IOBE estimations.

positive rate of change in the years 2008 and 2014, as well as in 2010-2012, i.e. a period with important economic developments. As far as technical efficiency is concerned, we observe a strong slowdown in its growth rate and a change in its trend after 2007, with positive rates of change only in 2010, 2014 and 2016. The rate of change of this component exerted the greatest effect on TFP growth, because in eight out of 14 years it is the component with the strongest contribution (more than 60% of the change in TFP).

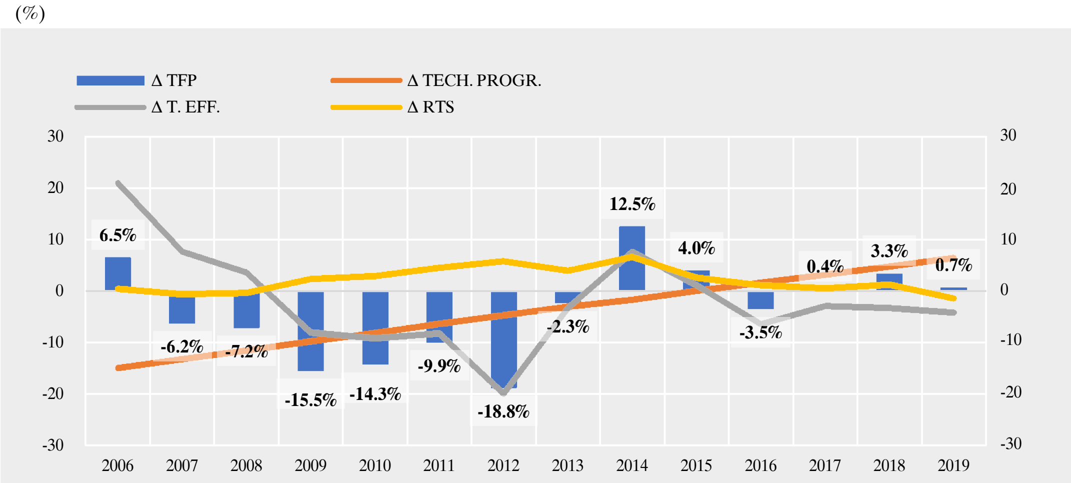
The Manufacture of rubber and plastic products (22) comes next. From the analysis of the trend of TFP (see Chart 5), it appears that in most years (8 out of 14) it had a positive growth rate (2006-2007, 2010, 2013-2014, 2016-2017 and 2019). However, its negative rates of change are on average stronger than the positive ones (2008: -5.2%, 2009: -14.1%, 2011: -9.6%, 2012: -2.5% and 2015: -3.1%). As was also the case for the previous sector, the rate of change of technical progress followed an

Chart 5 Growth rate of TFP and its components in the Manufacture of rubber and plastic products



Source: IOBE estimations.

Chart 6 Growth rate of TFP and its components in the Manufacture of other non-metallic mineral products



Source: IOBE estimations.

upward trend and turned positive in the 2016-2019 period, which probably reflects the increasing integration of new technologies by the sector. Returns to scale had a positive effect in the period 2009-2012. In most of the years in which the TFP growth rate was positive, this was the result of the improvement in technical efficiency, while in the years 2016-2017 and 2019 the positive effect of technology change also contributed. Overall, the most important component of TFP growth was the trend of technical efficiency.

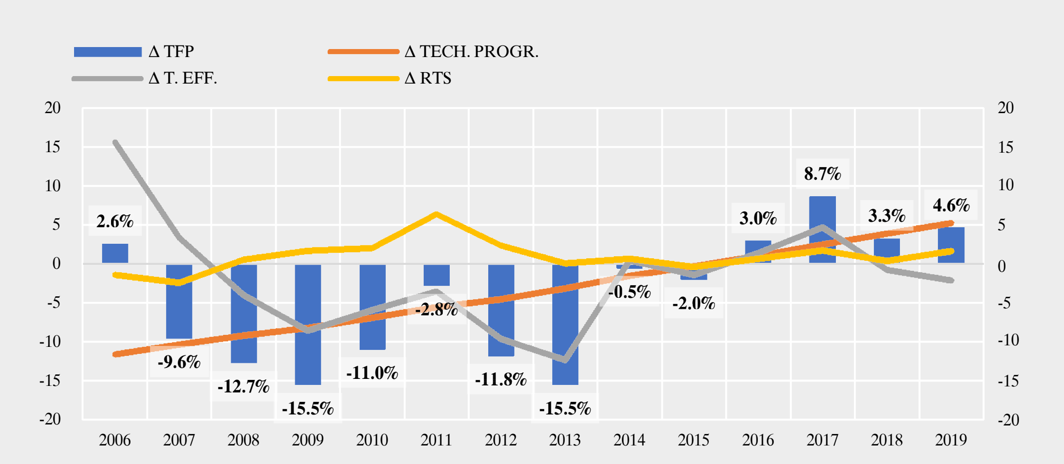
The TFP growth rate in the Manufacture of other non-metallic mineral products (23) was declining during the period 2007-2013 (see Chart 6), at a rate particularly strong (-14.6% on average) in the first three years of economic adjustment (2009-2012). This decline was primarily a result of the rate of change of technical efficiency. After 2012 and until 2019, the growth rate of TFP was positive, except for 2013 (-2.3%) and 2016 (-3.5%). This development was initially a result of the positive rate of change of economies of scale (2014-2015) and then the positive rate of change of technological progress (2017-2019). It should be noted that economies of scale recorded a positive rate of change throughout the period 2006-2019, except for the years 2007 (-0.67%), 2008 (-0.38%) and 2019 (-1.47%). Overall, the most important factor behind TFP growth was that of technological progress.

With respect to the Manufacture of fabricated metal products, except machinery and equipment (25), TFP growth (see Chart 7) followed a similar path as in the previous sector. In the period 2007-2015 it dropped significantly, especially until 2013 (-11.3% on average), and this was mainly due to the negative rate of change of technical efficiency, despite the positive rates of change of economies of scale. From 2016 onwards, the growth rate of TFP has been increasing (+4.9% on average) mainly on the back of positive rates of change of technological progress (+3.2% on average) and economies of scale (+1.1% on average). As in the previous sector, economies of scale had a positive rate of change throughout 2006-2019, except for 2006 (-1.4%), 2007 (-2.4%) and 2015 (-0.4%). The main driver of TFP growth was the trend in the rate of change of technological progress.

In the Construction of buildings (41), the TFP growth rate (see Chart 8) was negative during the period 2006-2019, except for the years 2007 (7.5%), 2013 (1.2%), 2014 (2.7%) and 2019 (2.2%). These negative rates were

Chart 7 Growth rate of TFP and its components in the Manufacture of fabricated metal products, except machinery and equipment

(%)

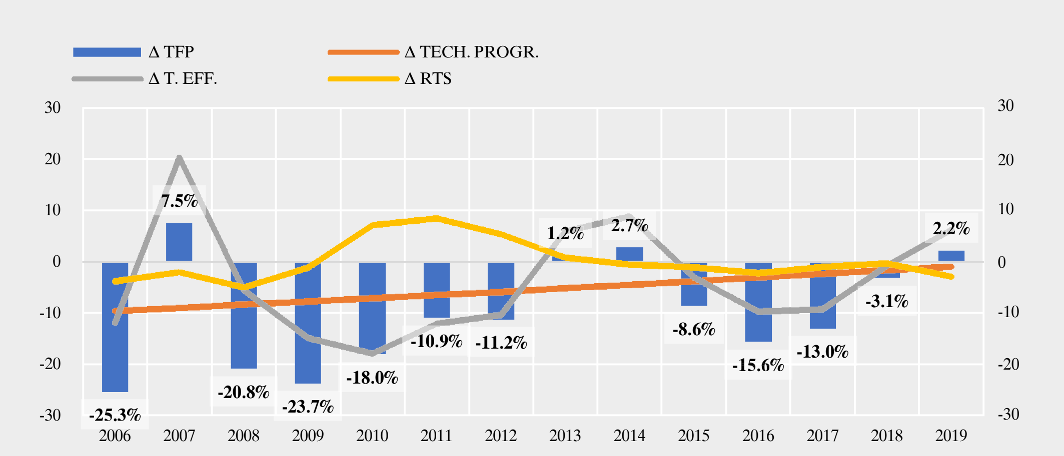


Source: IOBE estimations.

stronger during the first years of the economic crisis (2008-2012), mainly due to the negative rate of change of technical efficiency. During these years, the production index of the sector (seasonally adjusted) declined significantly, and it is possible that adjustments within firms as a reaction to this trend caused the deterioration of their technical efficiency. The rate of change of technological progress remained negative throughout the examined period and continuously decreased, while economies of scale exhibited positive rates of change only in the period 2010-2012. The difference in the trends of technical efficiency and economies of scale during the period of the financial crisis is remarkable. Probably, large firms have acquired smaller ones and the process of adapting to such changes was slow

Chart 8 Growth rate of TFP and its components in the Construction of buildings

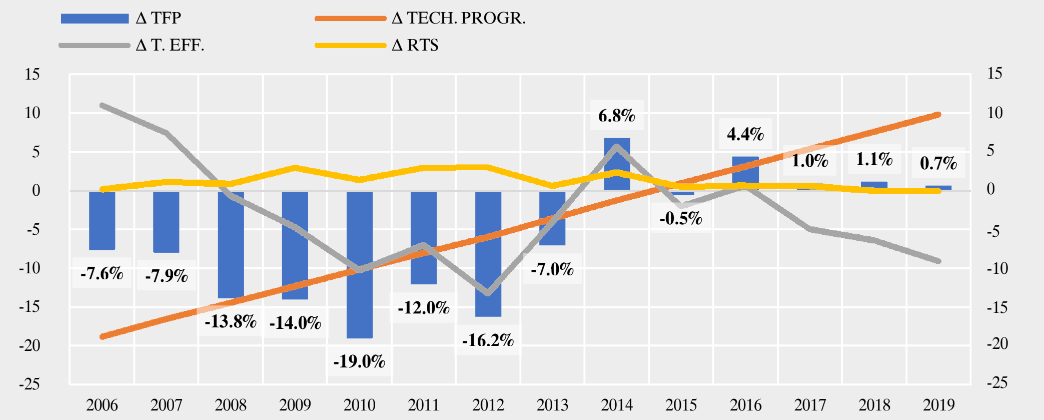
(%)



Source: IOBE estimations.

Chart 9 Growth rate of TFP and its components in the Wholesale-retail trade and repair of motor vehicles and motorcycles

(%)



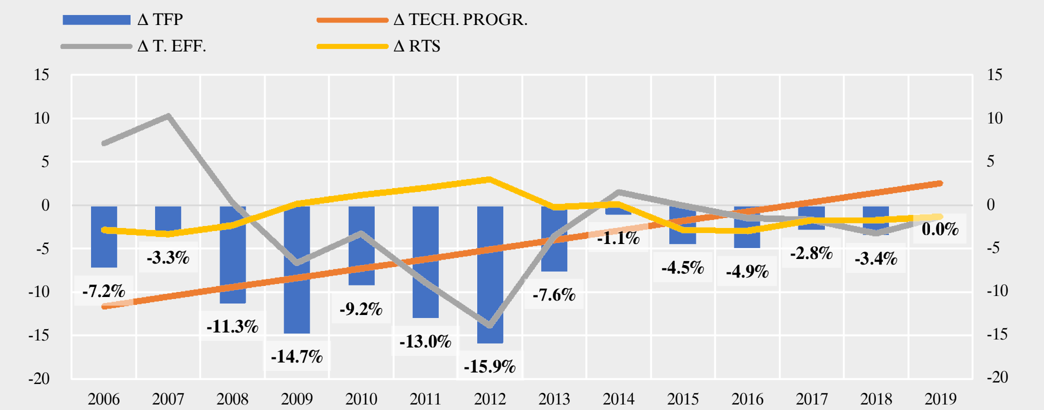
Source: IOBE estimations.

and difficult for the former. At the same time, it is possible that, due to the downturn in the real estate market during the crisis, these firms accumulated a large number of unsold properties, and in the crisis years their capital holdings would appear inflated and, as a result, returns to scale increased. Concluding, the main driver of TFP growth was the rate of change of technical efficiency.

Going to the next sector (Wholesale and retail trade and repair of motor vehicles and motorcycles – 45), TFP growth (see Chart 9) was negative during the 2006-2013 period, but it reached its lowest values during the economic crisis period (-15.0% on average), when the Greek economy suffered the deepest recession, and public and private consumption significantly declined. This trend was the result of the

Chart 10 Growth rate of TFP and its components in the Retail trade, except of motor vehicles and motorcycles

(%)



Source: IOBE estimations.

negative rate of change of technological progress (-9.9% on average) and the negative rate of change of technical efficiency (-6.0% on average). From 2014 onwards —except 2015— we observe a positive, although weakening, rate of change, which mainly resulted from the positive rate of change of technological progress (+5.4% on average) in the period 2016-2019. Overall, the most important factor of TFP growth in the period under examination was the rate of change of technological progress.

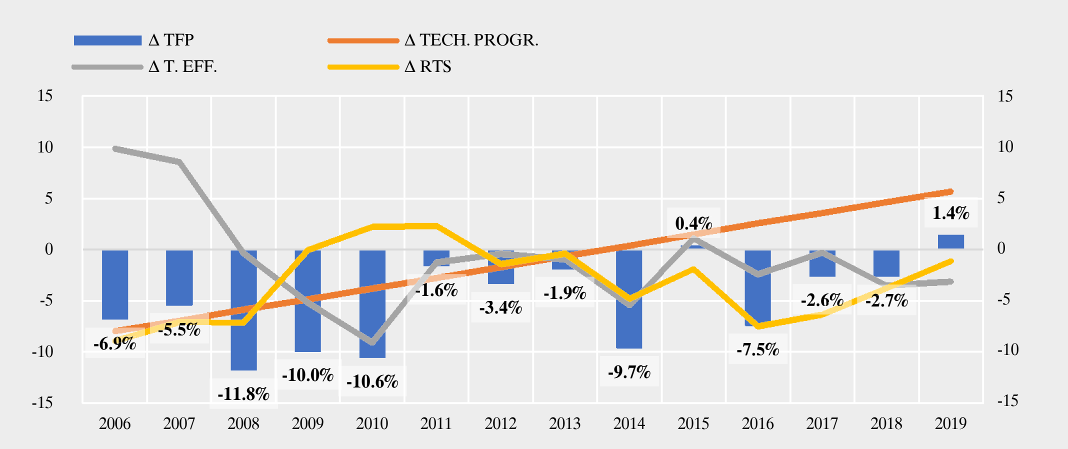
In Retail trade, except of motor vehicles and motorcycles (47), the TFP growth rate was negative throughout the period under examination; however, from 2013 onwards it became less intense (see Chart 10). As in the previous case, the strongest negative values occurred during the period 2008-2013 and were the result of a deterioration in the technical efficiency (-6.0% on average) and technological progress (-6.7%) rates of change. On the other hand, the lower decline in the rate of change of technological progress and its rebound during the period 2017-2019 (1.4% on average) was the main reason for the significantly less negative growth rate of TFP. Thus, the most important driver of TFP growth in this sector was the rate of change of technological progress.

In the next sector (Warehousing and support activities for transportation – 52), the TFP growth rate (see Chart 11) was negative throughout the period under examination, except for the years 2015 (+0.4%) and 2019 (+1.4%). The highest negative values occurred during the period 2008-2010 (-10.8% on average) due to the deterioration of technical efficiency and technical change, as well as in the years 2014 (-9.7%) and 2016 (-7.5%), as a result of the strong negative rates of change of technical efficiency and returns to scale. TFP growth rates moved up, albeit remaining negative, after 2014, to turn positive in 2019, driven by the positive rates of change of technological progress over the same period (+3.6% on average) and the decline in the negative rate of change in the returns to scale. Thus, the most important factor of TFP growth in this sector was the rate of change of the returns to scale component.

With respect to the Accommodation sector (55), the TFP growth rate (see Chart 12) exhibited significant fluctuations. We observe positive rates of change in 2006-2007, 2010-2011 and 2013-

Chart 11 Growth rate of TFP and its components in Warehousing and support activities for transportation

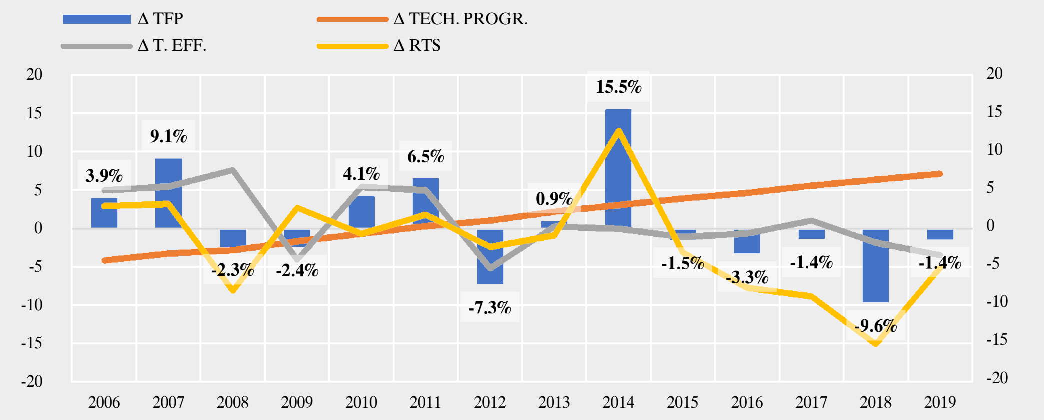
(%)



Source: IOBE estimations.

Chart 12 Growth rate of TFP and its components in Accommodation

(%)



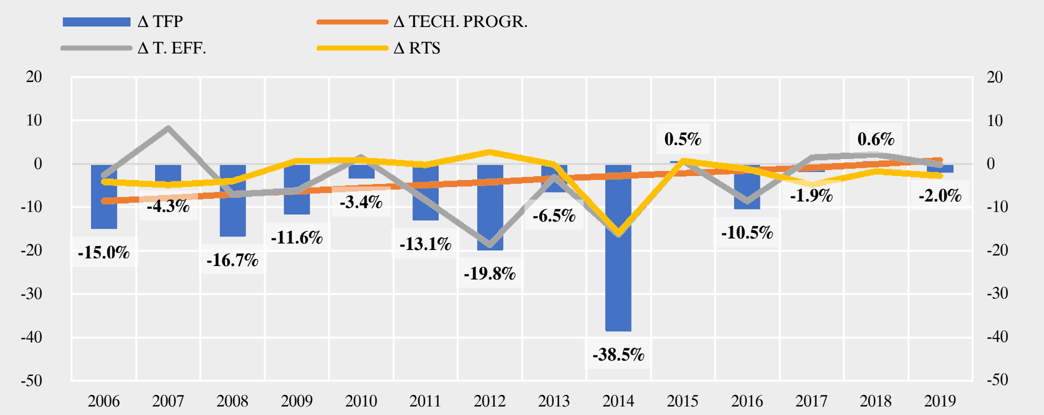
Source: IOBE estimations.

2014, and this was the result of the positive rates of change in technical efficiency (2006-2007 and 2010-2011) and in returns to scale (2013-2014). The drop of the latter by 8.0% on average is the main reason for the decline in TFP growth during the period 2015-2019, although technological progress has recorded a positive and increasing rate of change (+3.8% on average) from 2012 onwards. The most important component of the TFP growth rate during the period 2006-2019 was the trend in the rate of change of the returns to scale.

Continuing with Food and beverage service activities (56), we observe a negative TFP growth rate (see Chart 13) in the period 2006-2019, except for the years 2015 (+0.5%) and 2018 (+0.6%). Very strong negative rates were

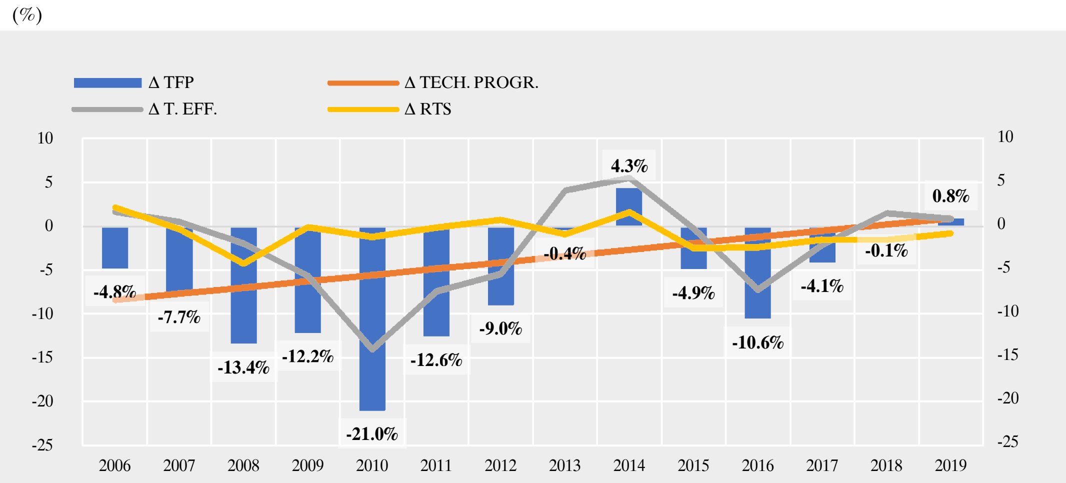
Chart 13 Growth rate of TFP and its components in Food and beverage service activities

(%)



Source: IOBE estimations.

Chart 14 Growth rate of TFP and its components in Computer programming, consultancy and related activities



Source: IOBE estimations.

recorded in most years of the period 2006-2014, while in 2014 the decline in TFP growth in this sector was the second largest (-38.5%) among the sectors we analyse in this study. This development can be attributed to the negative —albeit decreasing— rate of change of technological progress and technical efficiency. Especially in 2014, also the scale component (-15.9%) contributed to the very strong decline in TFP growth. During the period 2015-2019, the variation in TFP growth was much lower compared to the previous period. The most important factor of the growth rate of TFP for the whole period was the trend of technological progress.

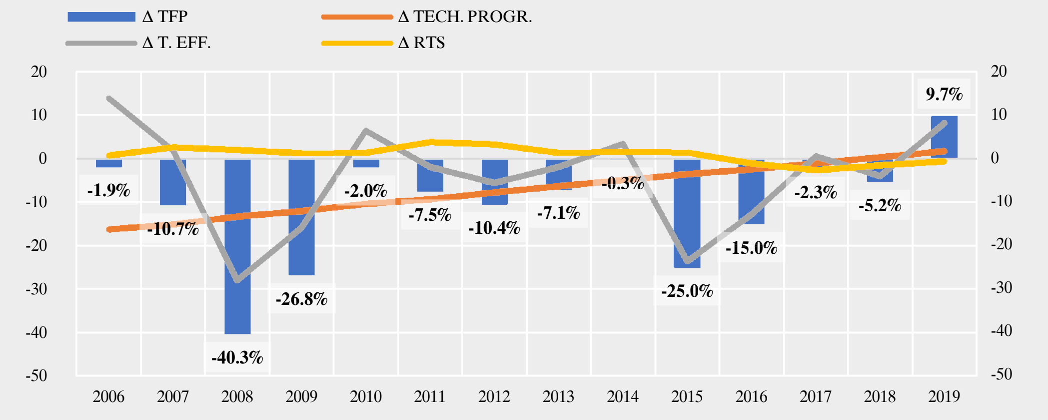
The analysis continues with the sector of Computer programming, consultancy and related activities (62). TFP growth (see Chart 14) was negative throughout the period under examination, except 2014 (+4.3%) and 2019 (+0.8%). In more detail, in 2006-2013 and 2015-2017, the curve of TFP growth was U-shaped, with the strongest negative effects taking place during the economic crisis period and the first three years of the economic adjustment process (2008-2012). The main factor behind the strong negative growth rate of TFP was the rate of change of technical efficiency, followed by technological progress. Economies of scale exerted a negative effect during the period under review, with the exception of the years 2006 (+2.1%), 2012 (+0.7%) and 2014 (+1.6%). Overall, the most important factor for the TFP growth rate was the rate of change of technical efficiency.

In the next sector (Real estate activities – 68), TFP growth (see Chart 15) was negative during the whole 2006-2019 period, except 2019 (+9.7%). The drop was stronger in the years 2007-2009, 2011-2013 and 2015-2016, while in 2008 (-40.3%) the drop was the strongest across all sectors examined. The negative rate of change came mainly from the negative rate of change of technological progress (-8.6% on average during the period 2006-2017). On the contrary, in the period 2006-2015 economies of scale exhibited a positive rate of change (+1.9% on average). The most important component in the TFP growth rate in this sector was the trend of technological progress.

In Architectural and engineering activities, technical testing and analysis (71), TFP growth (see Chart 16), although negative on average, showed strong fluctuations over the period 2006-2019. The longest period of declining

Chart 15 Growth rate of TFP and its components in Real estate activities

(%)



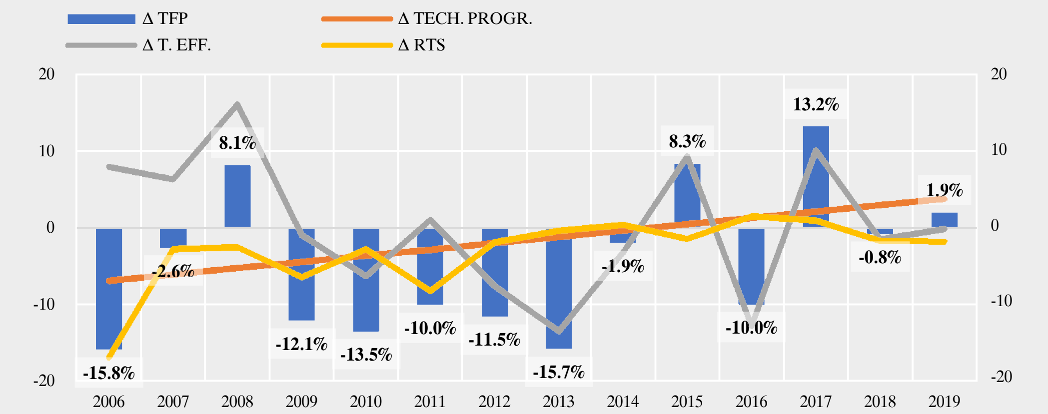
Source: IOBE estimations.

TFP growth was from 2009 to 2013 (-10.8% on average), i.e. during the outbreak of the financial crisis and the first four years of the economic adjustment programmes, and it was mainly due to the rate of change of technical efficiency (-5.5% on average) and the negative rate of change of economies of scale (-4.0% on average). In the years that TFP had a positive rate of change, this came mainly from the improvement in technical efficiency (2008: +8.1%, 2015: +8.3%, 2017: 13.2%), and in 2019 (+1.9%) from the positive rate of change of technological progress. Overall, the trend in technological progress was the most important factor for the growth rate of TFP.

Going to the last sector (Human health activities – 86), in the years 2006-2007, TFP (see

Chart 16 Growth rate of TFP and its components in Architectural and engineering activities; technical testing and analysis

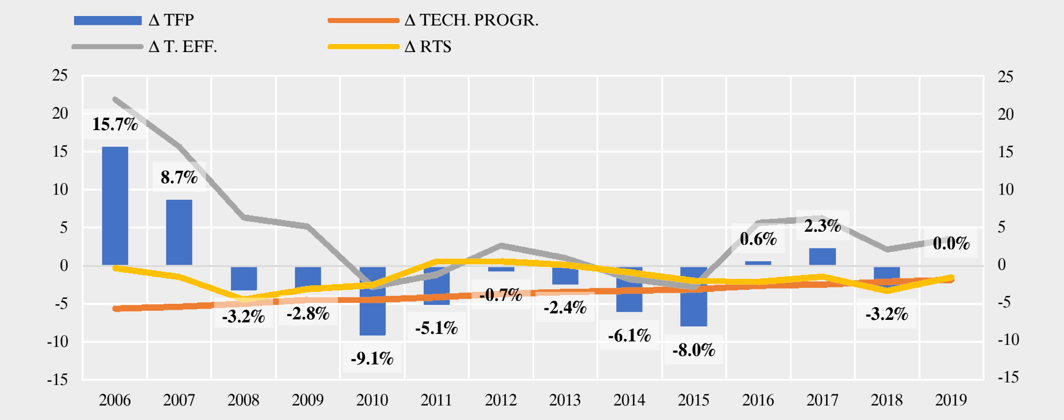
(%)



Source: IOBE estimations.

Chart 17 Growth rate of TFP and its components in Human health activities

(%)



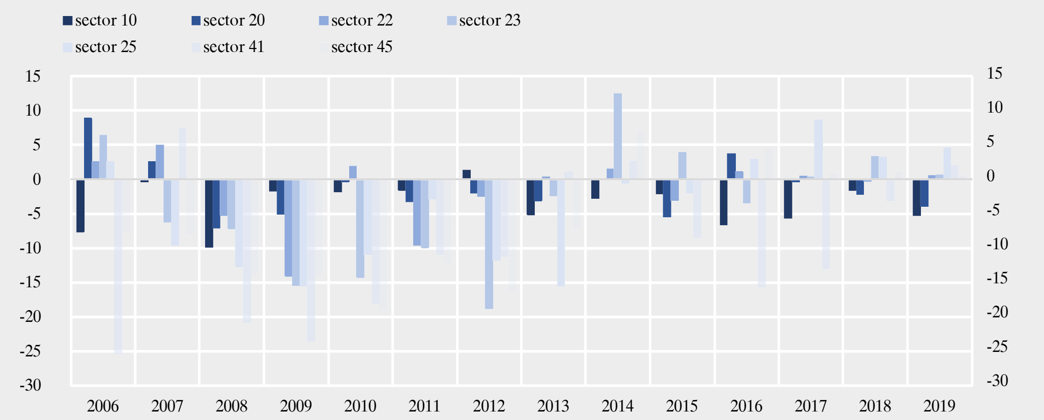
Source: IOBE estimations.

Chart 17) recorded a strong positive rate of change (+15.7% and +8.7%, respectively) as a result of the strong positive rate of change of technical efficiency (+21.9% and +15.6%). Since then and until 2015, TFP showed a negative rate of change (-4.7% on average) mainly due to the negative rate of change of technological progress (-4.0% on average), as technical efficiency increased marginally (+0.8% on average) and economies of scale declined slightly. During the period 2016-2019 —except 2018— TFP growth showed a marginal increase, as a result of the positive rate of change of technical efficiency (+4.4% on average) that offset the negative rates of change of technological progress (-2.3%) and of economies of scale (-2.1%). The trend of technological progress was the most important factor for the evolution of TFP growth in this sector.

Concluding, from the results presented above, it emerges that the vast majority of the sectors examined suffered negative TFP growth mainly during the period of the economic crisis and in the first 3-4 years of implementation of the economic adjustment programmes (see Charts 18 and 19). The main reason for this behaviour was the deterioration in the rate of change of technical progress (in eight out of fifteen sectors). However, this negative impact weakened over time and in the most recent years turned positive. The next important factor for the trend in TFP growth was the rate of change of technical efficiency (main factor in four sectors). Its negative effect was strong in the first years of the period 2006-2019, but in the following years it became milder. Also, in the majority of sectors, the effect of the returns to scale was positive during the first years of economic adjustment (2010-2012), and it was the least important factor for the evolution of TFP growth (third in importance, in 10 out of 15 sectors). Moreover, TFP growth showed positive values in some sectors, either in the period before the economic crisis (2006-2007) or during the period 2016-2019 or in both periods (Manufacture of rubber and plastic products, Manufacture of other non-metallic mineral products, Manufacture of fabricated metal products, except machinery and equipment, Human health activities). In addition, what emerges from the estimations is the linearity of the technical progress curve, although in some sectors (e.g. 25, 56, 68, 86), if we isolate the diagram of technical change, its path is not completely linear, but shows small fluctuations. This

Chart 18 Evolution of TFP growth by sector (NACE Rev. 2)

(%)

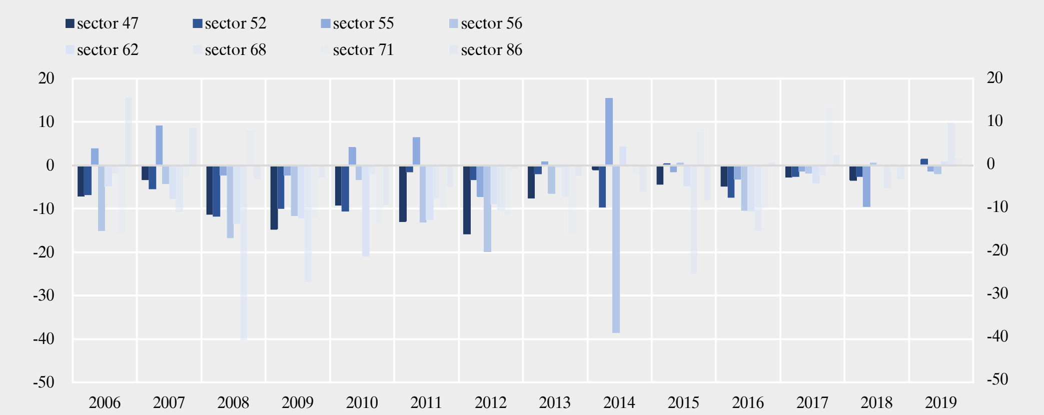


Source: IOBE estimations.

behaviour may indicate that the scale of the estimation is dependent on the initial values. However, this linearity is not completely surprising. Significant variability would mean large changes in the level of technology used on an annual basis, which may not be the case in the Greek economy, because it is basically service-intensive and its manufacturing sector —with some exceptions— is not characterised by high technology usage or significant technological changes over time. Finally, based on the average growth rate of TFP, the worst performing sectors during the period 2006-2019 were Real estate activities (-10.3%), Food and beverage service activities (-10.2%) and Construction of buildings (-9.8%). On the contrary, the sectors with the best performance were Accommodation (+0.8%) —the only

Chart 19 Evolution of TFP growth by sector (NACE Rev. 2)

(%)



Source: IOBE estimations.

sector with a positive average rate of change—, Human health activities (-1.0%), Manufacture of chemicals and chemical products (-1.2%) and Manufacture of rubber and plastic products (-1.5%). The worst and best performing sectors do not appear to have particular characteristics, because both include tradable as well as non-tradable sectors.

6.2 ESTIMATIONS FOR EXPORTING AND NON-EXPORTING FIRMS

In order to evaluate whether TFP growth follows a different trend in the case of exporting firms, we re-estimated our model only for this group of firms[8] in each sector. Before this exercise, we conducted a statistical test to examine whether it is statistically significant to perform separate estimates only for the sample of exporting firms in each sector. From the above test it emerged that we can perform separate estimates for exporting firms in the sectors of Manufacture of chemicals and chemical products (20), Manufacture of rubber and plastic products (22), Manufacture of fabricated metal products, except machinery and equipment (25), Wholesale and retail trade and repair of motor vehicles and motorcycles (45), Retail trade, except of motor vehicles and motorcycles (47), and Computer programming, consultancy and related activities (62). We should mention that for sectors 41, 52, 55, 56, 68 and 86 the estimation results were statistically insignificant and thus, we do not analyse the trend of the TFP growth in these sectors.

Summarising the econometric results,[9] in most of the sectors examined, exporting firms exhibit less negative average growth rate of TFP during the period 2006-2019 compared with the total number of firms in each sector (see Chart 20). This difference mainly results from the evolution of TFP growth in some years during the period of the economic crisis and implementation of the first two economic adjustment programmes (2008-2014). In more detail, in most years of this sub-period, the TFP growth curve of exporting firms is above the corresponding curve concerning the total number of firms. This implies either less negative rates of change or stronger positive rates of change for exporting firms. Probably, the production of these firms was more resistant to the pressures exerted due to the domestic and global economic crisis, and as a result the components of TFP were less affected. In addition, in four of the sectors examined (20, 22, 45 and 62) the most important factor in TFP growth was the rate of change of technical efficiency, while in two sectors (25 and 47) it was the rate of change of technological progress.

6.3 ESTIMATIONS FOR MEDIUM-SIZED AND LARGE FIRMS

We also performed estimations for the selected sectors focusing on the sub-sample of medium-sized and large firms to check whether TFP growth differs between these two groups of firms and the firms of the initial sample. According to the literature, large firms possess the necessary amounts of physical and human capital that allow them to survive and grow, as opposed to small competitors. Also, large firms achieve economies of scale with the direct consequence of operating at a lower average production cost curve (see for example Geroski 1995; Blomström and Kokko 1998; Dimelis and Louri 2004; Tsionas and Papadogonas 2006). For the purpose of our analysis, we consider as medium-sized and large firms those with an average turnover of more than €10.0 million, in line with the relevant definition of the European Commission.[10] In this context, we performed estimations for sectors 10, 20, 22, 25, 45 and 47. The remaining sectors either had a small number of observations (and statistically

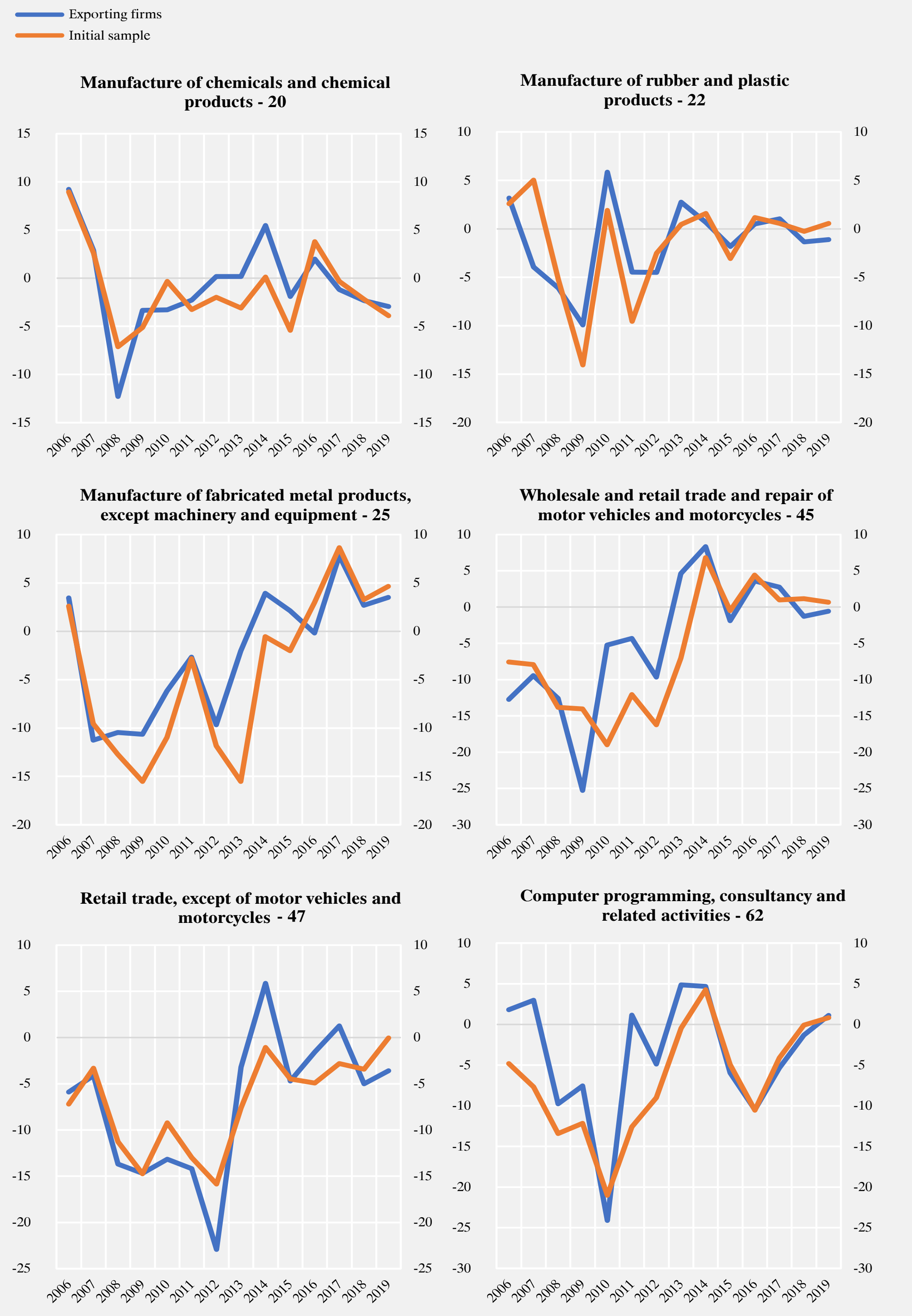
8 If we compare exporting and non-exporting firms, the former are larger in terms of turnover (€11.5 million on average vs €3.9 million on average in 2005-2019), number of employees (90 vs 35), assets (€13.5 million vs €3.2 million), fixed assets (€10.0 million vs €2.1 million) and EBITDA (€918.7 thousand vs €163.5 thousand) and are older (21 vs 15 years old).

9 Due to space limitations, all these additional estimations are not presented here but are available upon request.

10 According to the relevant definition of the European Commission, there are four size categories: micro (average annual turnover < €2.0 million), small (€2.0 million ≤ average annual turnover < €10.0 million), medium (€10.0 million ≤ average annual turnover < €50.0 million) and large firms (average annual turnover ≥ €50.0 million).

Chart 20 Evolution of TFP growth, exporting firms vs initial sample

(%)



Source: IOBE estimations.

insignificant estimation results) or the corresponding tests to assess whether it is statistically significant to perform separate estimates only for this group of firms gave statistically insignificant results.

Summarising the econometric results,[11] in the majority of sectors, the curve of TFP growth of medium-sized and large firms lies above the corresponding curve for the whole sample during the period 2006-2019. This result shows that the former achieve a better rate of change of TFP relative to the latter. In the case of Manufacture of rubber and plastic products (22), the TFP growth rate dropped faster compared with the total sample, whereas in the case of Wholesale and retail trade and repair of motor vehicles and motorcycles (45), the difference in the average negative TFP growth rate between the two samples was marginal, with this rate being slightly lower in the case of medium-large firms. Also, in Manufacturing of food products (10) and Manufacture of chemicals and chemical products (20), the average TFP growth was positive, as opposed to that of the total sample (which was negative). The better results of TFP growth for medium-sized and large firms may reflect the fact that these firms were better placed to respond to the fluctuations and transformations in the Greek, European and global economies in the period under review, e.g. due to higher profitability before and during this period, easier access to bank financing, export activity, etc. Finally, in most sectors the factor that mostly affected TFP growth was the rate of change of technical efficiency. In sector 45 the main factor was technical progress and in the Retail trade, except of motor vehicles and motorcycles sector, the scale component.

6.4 ICT-INTENSIVE FIRMS, FIRMS THAT SURVIVED DURING THE 2006-2019 PERIOD AND FIRMS THAT DID NOT SURVIVE

In addition, we performed estimations for all the firms of the initial sample that are ICT-intensive,[12] as well as for all the firms of the initial sample that survived or did not survive the whole 2005-2019 period. As far as the first group of firms is concerned, these firms are characterised by high rates of innovation in products/services. The examination of the evolution of their TFP growth is interesting if we take into account that the time horizon of the study (2005-2019) includes a period (2008-2013) during which investments in ICT fell by 52.9%, although from 2014 onwards they recovered 51.7% of their previous decline.[13] With respect to the other two categories, the study of TFP growth is of specific interest, as it may differ between the two categories, while it is possible that the factors that mainly influence its trend may differ in magnitude.

Starting with ICT-intensive firms,[14] throughout the 2006-2019 period —except 2014 and 2019— they had a negative TFP growth rate, which was increasing in the 2006-2010 period, and for the entire period had a negative average value (-5.9%). This picture is probably the result of unfavourable macroeconomic conditions, due to the global financial crisis, the debt crisis in Greece, as well as in other euro area countries (Portugal, Ireland, Cyprus), and the implementation of three economic adjustment programmes. Overall, the most important factor for TFP growth of ICT-intensive firms was the rate of change of technical efficiency.

Going to the firms that have not survived the whole 2005-2019 period, TFP growth was negative, and its average annual value was very strong (-15.0%). This picture is thought to explain their failure to survive. In contrast to the previous categories of firms, the drop in TFP growth for non-surviving firms exacerbated during the years of capital controls and of the implementation of the third economic adjustment programme. It is possible that

11 As in the case of exporting and non-exporting firms, due to space limitations, all these additional estimations are not presented here but are available upon request.
12 According to the OECD, ICT-intensive sectors are the following: 26.1, 26.2, 26.3, 26.4, 26.8, 46.51, 46.52, 58.2, 61.10, 61.20, 61.30, 61.90, 62.01, 62.02, 62.03, 62.09, 63.11, 63.12, 95.11, 95.12.
13 Data from ELSTAT's national accounts.
14 As in previous cases, due to space limitations, all the estimations for ICT-intensive, surviving and non-surviving firms are not presented here but are available upon request.

many of these firms —whose productivity had already been under pressure since the outbreak of the economic crisis— were negatively affected by developments in the Greek economy after 2014, their productivity deteriorated further, and as a result they exited the market. The main determinants of TFP growth were both technological progress and technical efficiency.

In the case of the firms that have survived the whole period of interest, TFP had, on average, a negative rate of change during the period 2006-2019 —except 2014 (+3.1%)— but this average rate of change was 11.1 percentage points lower (-3.9%) than that of non-surviving firms. In this case the most important determinant of TFP growth was the rate of change of technological progress.[15]

7 POLICY IMPLICATIONS

The estimations showed that export-oriented firms exhibited a smaller decline in TFP growth compared to non-exporting firms, or even an increase, probably because their production showed less volatility during the period of the financial crisis, because their production of tradable goods/services does not solely depend on the domestic market. Therefore, they undertook a smaller restructuring of their production process and produced at a point closer to the production frontier. Similar developments may have taken place in ICT-intensive industries, due to the positive effects on their TFP from the use of technologies that allow them to be more efficient and competitive. Thus, support for export-oriented and ICT-intensive firms should be one of the main objectives of economic policy in order to achieve strong recovery and sustainable growth of the Greek economy and its further orientation towards the production of tradable goods/services.

Starting with exports, their support is included in the policy objectives of the National Recovery and Resilience Plan ("Greece 2.0"). This support will take the form of grants, as well as loans from the banking system. Also, in the context of the "EU Cohesion Policy 2021-2027", the strengthening of competitiveness and export activity is supported by its specific objectives. The implementation of actions under these specific objectives will be financed by the European Regional Development Fund and the European Social Fund Plus (ESF+). In addition, the "Operational Programmes" of the "Partnership Agreement for the Development Framework 2021-2027" (ESPA 2021-2027) include actions and financing of investment projects to stimulate the extroversion of the Greek economy. These programmes include the "Competitiveness 2021-2027" programme, the 13 "Regional Programmes" and the "Human Resources and Social Cohesion 2021-2027" programme. Furthermore, the Ministry of Foreign Affairs assists firms wishing to develop their export orientation, as well as exporting firms seeking new markets through the creation of the "Agora" portal, which provides information on the supply of and demand for business partnerships from abroad, business exhibitions abroad, the organisation of business missions, etc. The Hellenic Federation of Enterprises (SEV) has launched the "Export Ready" programme under which the largest members of the association provide practical advice and know-how to exporting firms, based on their knowledge and experience from their export activity. As far as the activities of the chambers are concerned, they organise business missions and the participation of domestic firms in exhibitions abroad, they provide information on foreign local markets, etc.

With respect to ICT-intensive industries, one of the four pillars of the "Greek Recovery and Resilience Plan" is dedicated to digital technologies (second pillar: digital transformation) focusing on specific reforms and policy proposals. Furthermore, in the context of the "EU Cohesion Policy 2021-2027", supporting the adoption of ICT technologies by firms is pro-

15 We performed additional estimations using value added as the dependent variable of the production function instead of turnover. The discussion of these results is presented in the Appendix.

moted under Policy Objective 3, as well as by some of its specific objectives. The implementation of actions under specific objectives will be financed by the European Regional Development Fund, the Cohesion Fund and the European Social Fund Plus (ESF+). The adoption of ICT technologies will also be supported by the "Digital Europe" programme designed to bridge the gap between digital research and market penetration. The programme intends to benefit European citizens and firms, especially SMEs. Finally, the "Operational Programmes" of the "Partnership Agreement for the Development Framework 2021-2027" (ESPA) include actions and financing of investment projects to support the development and adoption of ICT technologies by firms.

8 CONCLUSION

The purpose of this paper is to estimate TFP growth for 2-digit sectors of the Greek economy using firm-level data. To do this, a sample of firms of all sizes active in fifteen 2-digit sectors of the Greek economy in the period 2005-2019 is used. TFP growth is the sum of the rate of technical change, the rate of change of technical efficiency and the rate of change of the returns to scale, i.e. we do not adopt a full efficiency assumption in production. To estimate the components of TFP growth, we estimate a stochastic production frontier. The study contributes to the literature as one of the very few studies that estimate the TFP of the Greek economy using firm-level data. Also, the estimation takes into account the effect of inefficiencies in production and the sample used does not only include firms that have survived the whole 2005-2019 period, but also those that exited or entered the market.

The estimations show that the vast majority of sectors suffered a negative TFP growth rate mainly during the period of the economic crisis and in the first 3-4 years of implementation of the economic adjustment programmes, due to the deterioration in the rate of change of technical progress. However, in the following years this negative rate of change slowed down. In addition, TFP growth showed positive values in some sectors, either in the period before the economic crisis (2006-2007) or during the period 2016-2019 or in both periods. The worst performing sectors during the period 2006-2019 include sectors such as Real estate activities (-10.3%), Food and beverage service activities (-10.2%), etc. Sectors with the best performance include Accommodation (+0.8%), Human health activities (-1.0%), etc.

Exporting firms exhibit a less negative average TFP growth rate during the period 2006-2019 compared with the total number of firms in each sector. This implies either less negative rates of change or stronger positive rates of change for these firms. Probably, the production of these firms was more resistant to the pressures exerted due to the economic crisis and, as a result, the components of TFP were less affected.

Also, in most of the sectors, the curve of TFP growth for medium-sized and large firms lies above the corresponding curve for the whole sample during 2006-2019. This result may reflect the fact that these firms were better placed to respond to fluctuations and transformations in the Greek, European and global economies in the period under review, e.g. due to higher profitability before and during this period, easier access to bank financing or export activity.

ICT-intensive firms had a negative TFP growth rate, which was increasing in the 2006-2010 period and for the entire period had a negative average value (-5.9%). This is probably the result of the unfavourable macroeconomic conditions, due to the financial crisis and the implementation of the economic adjustment programmes.

The firms that have not survived the entire 2006-2019 period had a strong negative average annual TFP growth rate (-15.0%) and this result probably explains their failure to survive. In contrast to the previous categories of firms, the drop in TFP growth for non-surviving firms was exacerbated during the years of capital controls and of the implementation of the third economic adjustment programme. It is possible that many of these firms —whose productivity had already been under pressure since the outbreak of the economic crisis— were negatively affected by developments in the Greek economy after 2014, their productivity deteriorated further and, as a result, they exited the market.

In the case of the firms that have survived the whole period of interest, TFP had, on average, a negative rate of change, which was 11.1 percentage points lower (-3.9%) than that of non-surviving firms.

Finally, the results reflect a decline or small fluctuations in productivity indicators for most 1-digit sectors since 2011 or 2012, in relation to their levels before the economic crisis. Exceptions to this trend are the sectors of Mining-Quarrying (B), Information and Communication (J) and Administrative and support service activities (N).

Further research on this topic includes the estimation of TFP of the Greek economy using real data for materials, investments and value added. This would allow to implement control function methods (e.g. Ackerberg et al. 2015) and check for the robustness of this study. Another approach would be to use technical (in)efficiency terms as a function of firm- or sectoral-level characteristics and check for the indirect effect of these factors on TFP through the (in)efficiency term. Such data will surely yield worthwhile insights into how TFP evolves over time.

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APPENDIX

Table A1 Degree of representativeness of the number of firms by turnover category and sector

Sector	€0-€0.5 million	€0.5-€1.5 million	€1.5-€5 million	€5-€50 million	over €50 million
A – Agriculture, forestry and fishing	0.1%	13.3%	58.9%	116.1%	117.2%
B – Mining and quarrying	15.1%	50.4%	73.4%	93.5%	26.1%
C – Manufacturing	4.4%	42.8%	81.2%	99.7%	111.4%
D – Electricity, gas, steam and air conditioning supply	21.9%	61.4%	77.3%	81.9%	133.1%
E – Water supply; sewerage, waste management and remediation activities	6.9%	35.2%	43.5%	50.5%	80.7%
F – Construction	3.0%	33.5%	63.1%	81.7%	58.6%
G – Wholesale and retail trade; repair of motor vehicles and motorcycles	2.4%	16.7%	45.4%	71.0%	86.6%
H – Transportation and storage	1.4%	25.6%	48.9%	61.8%	93.0%
I – Accommodation and food service activities	3.3%	39.6%	77.2%	101.8%	104.8%
J – Information and communication	7.6%	53.7%	81.8%	101.7%	101.3%
K – Financial and insurance activities	3.4%	34.2%	46.8%	46.0%	14.2%
L – Real estate activities	32.7%	76.7%	81.9%	126.5%	94.1%
M – Professional, scientific and technical activities	1.7%	39.4%	55.6%	82.6%	81.2%
N – Administrative and support service activities	5.7%	46.9%	72.4%	96.9%	89.7%
O – Public administration and defence; compulsory social security	0.4%	0.8%	4.9%	150.0%	33.3%
P – Education	1.4%	52.2%	78.6%	168.9%	0.0%
Q – Human health and social work activities	1.3%	54.6%	89.2%	95.2%	190.2%
R – Arts, entertainment and recreation	1.2%	25.4%	64.7%	68.6%	80.0%
S – Other service activities	0.5%	15.9%	29.4%	42.5%	0.0%
Total	**2.1%**	**26.5%**	**57.2%**	**81.1%**	**89.3%**

Sources: ICAP Data.prisma, ELSTAT and IOBE calculations.
Notes: The cases where the percentage exceeds 100% are probably due to errors in the categorisation. The figures refer to the average of the years 2011-2019.

Table A2 Contribution to employment by sector, by size class in terms of employment (2011-2019 average)

Sectors	B	C	D	E	F	H	I	J	L	M	N	S
ICAP Data.prisma												
0-9 employed	5%	4%	5%	3%	15%	3%	13%	4%	27%	10%	5%	13%
10-19 employed	10%	9%	2%	7%	12%	4%	16%	7%	18%	9%	5%	20%
20-49 employed	13%	19%	3%	14%	18%	7%	23%	14%	23%	16%	10%	34%
50-249 employed	35%	36%	9%	30%	26%	14%	29%	23%	24%	28%	24%	33%
250+ employed	37%	32%	81%	45%	30%	72%	20%	52%	7%	37%	56%	0%
Eurostat/SBS												
0-9 employed	12%	25%	14%	12%	41%	27%	35%	24%	62%	43%	16%	82%
10-19 employed	11%	10%	2%	9%	16%	9%	21%	12%	18%	11%	8%	8%
20-49 employed	12%	15%	3%	20%	16%	10%	21%	18%	10%	12%	12%	3%
50-249 employed	22%	26%	5%	36%	16%	16%	16%	16%	8%	18%	23%	3%
250+ employed	43%	25%	76%	22%	11%	37%	6%	31%	3%	15%	41%	3%

Sources: ICAP, Eurostat and IOBE calculations.

Table A3 Contribution to turnover by sector, by size class in terms of employment (2011-2019 average)

Sectors	B	C	D	E	F	G	H	I	J	L	M	N	S
ICAP Data.prisma													
0-9 employed	12%	6%	7%	13%	24%	16%	13%	46%	6%	60%	25%	23%	32%
10-19 employed	9%	6%	2%	10%	12%	11%	7%	16%	4%	8%	11%	12%	14%
20-49 employed	13%	12%	10%	17%	11%	17%	12%	14%	9%	17%	19%	20%	30%
50-249 employed	41%	27%	22%	20%	13%	30%	22%	15%	15%	12%	32%	23%	24%
250+ employed	25%	50%	59%	40%	40%	26%	46%	8%	66%	4%	13%	23%	0%
Eurostat/SBS													
0-9 employed	13%	12%	12%	15%	43%	42%	32%	38%	17%	70%	54%	26%	80%
10-19 employed	8%	5%	2%	9%	11%	10%	9%	15%	7%	11%	9%	10%	6%
20-49 employed	9%	8%	19%	19%	13%	12%	12%	16%	13%	11%	13%	21%	3%
50-249 employed	26%	19%	10%	29%	15%	19%	17%	20%	12%	6%	18%	21%	6%
250+ employed	43%	56%	56%	29%	18%	16%	30%	10%	51%	2%	6%	22%	5%

Sources: ICAP, Eurostat and IOBE calculations.

ESTIMATIONS WITH VALUE ADDED AS A DEPENDENT VARIABLE

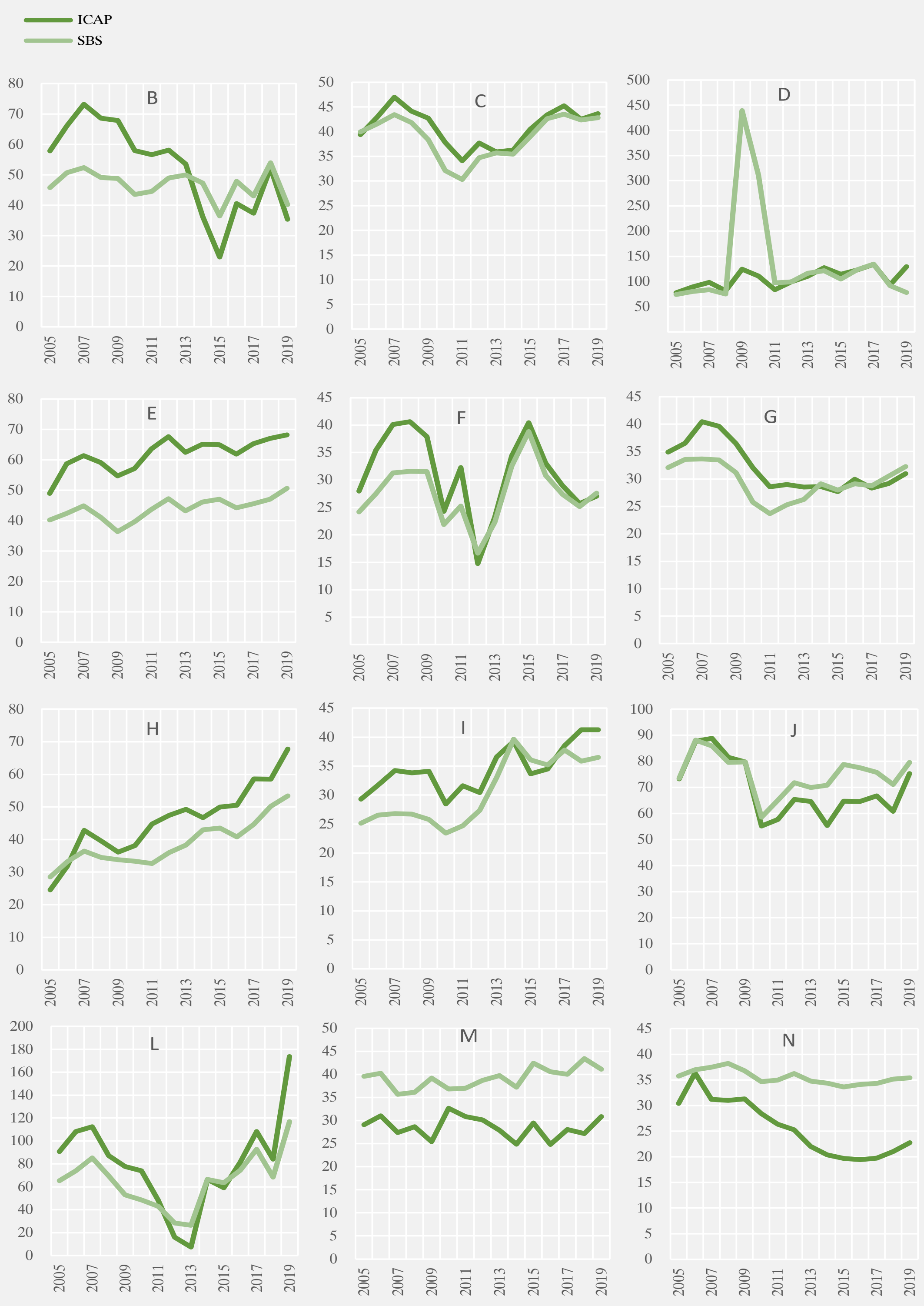
We performed additional estimations using value added instead of turnover as the dependent variable of the production function. We follow this procedure for two reasons. First, to check for the robustness of the initial results and second because very often the relevant literature uses value added as the dependent variable in the production function to estimate TFP.

From the estimation results[16] we conclude that in most of the sectors examined the trend of TFP growth has a similar evolution as in the case where we used turnover as a dependent variable. Significant differences between the two trends are observed in the sectors of Food and beverage service activities (56), Computer programming, consultancy and related activities (62) and Human health activities (86). Moreover, in 10 out of 15 sectors we have more years with positive rates of change of TFP, compared with those in the case of model estimation using turnover as dependent variable. Also, in three sectors we have the same number of years with positive rates of change. In addition, in the estimations with value added, the average growth rate of TFP is higher than in the case of the initial estimations. An opposite trend of TFP between the two cases emerges in the case of Manufacture of rubber and plastic products (22), Manufacture of other non-metallic mineral products (23), Accommodation (55) and Human health activities (86). Finally, in contrast to the initial estimates (technological progress), the main factor that affects TFP growth in the case of the value-added model is the change in technical efficiency.

16 As in the previous cases, due to space limitations, all these additional estimations are not presented here but are available upon request.

Chart A1 Apparent productivity of labour (value added over employed persons), by sector of the business economy (EUR thousands)

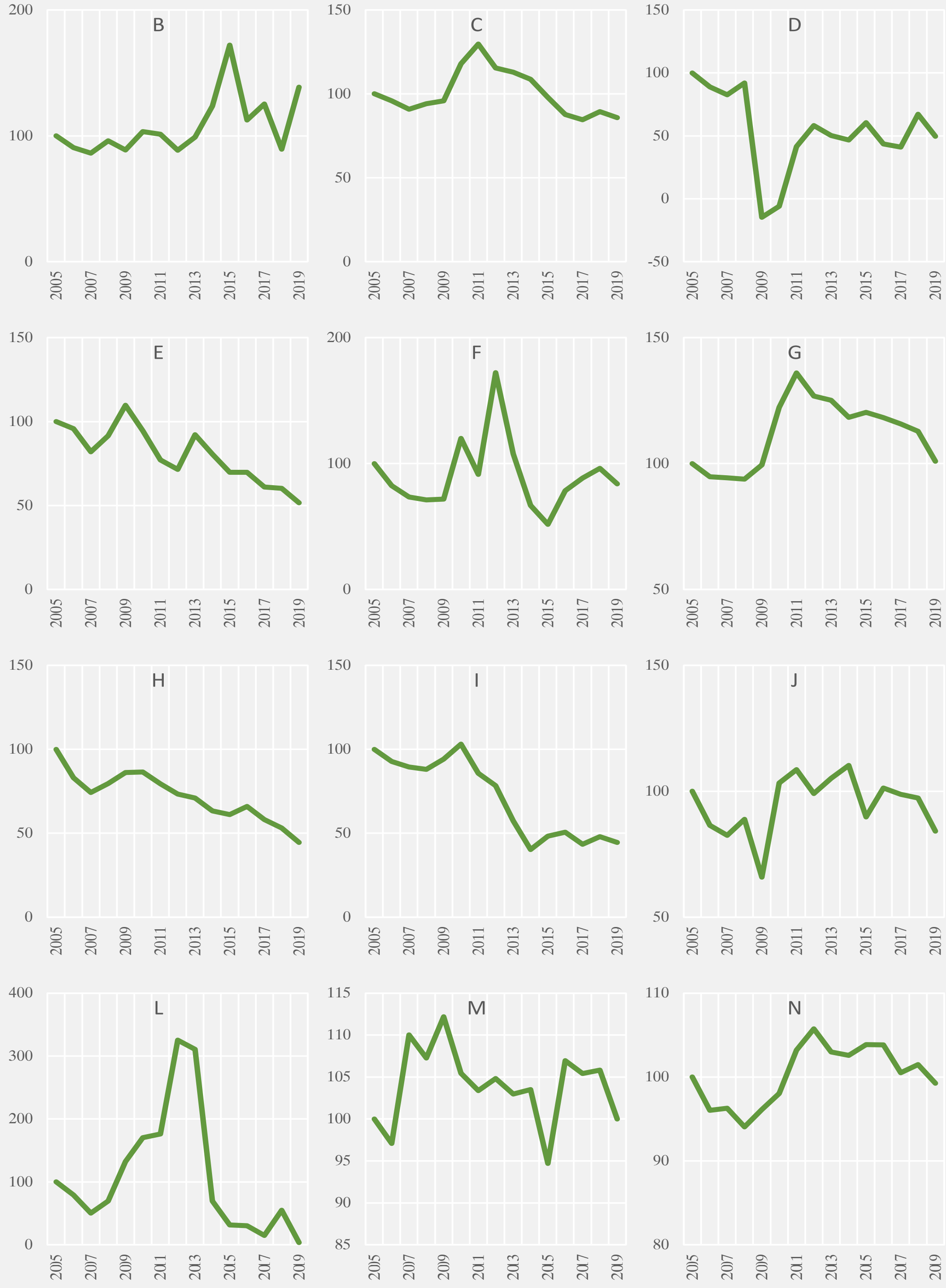
(%)



Sources: ICAP Data.prisma, ELSTAT (SBS and National Accounts) and IOBE calculations.

Chart A2 Total Factor Productivity by sector of the business economy (index 2005=100)

(%)



Sources: ICAP Data.prisma, ELSTAT (SBS and National Accounts) and IOBE calculations.

Table A4 Translog production function estimations

	10	20	22	23	25	41	45	47	52	55	56	63	68	71	86
β_L	0.0126	0.3568**	0.8727***	-0.3440**	-0.4413***	0.0361	0.2150**	0.6478***	0.3380***	0.3467***	0.4119***	0.3887***	0.5899***	0.3858***	0.7019***
	(0.0619)	0.1499	(0.1713)	(0.1216)	(0.0912)	(0.1145)	(0.1157)	(0.0585)	(0.0693)	(0.0596)	(0.1168)	(0.1034)	(0.2280)	(0.1335)	(0.0809)
β_K	-0.1061**	-0.0900	-0.2909**	-0.0786	0.1144**	0.0814	0.0149	-0.2851***	-0.2073***	-0.7560***	-0.3030***	0.1513*	-0.2035	-0.0482	-0.0063
	(0.0423)	(0.0672)	(0.1334)	(0.0825)	(0.0524)	(0.0765)	(0.0925)	(0.0393)	(0.0321)	(0.0620)	(0.0426)	(0.0801)	(0.1270)	(0.0575)	(0.0448)
β_T	-0.0381***	-0.1672***	-0.0793***	-0.2854***	-0.0455**	-0.0575**	-0.1892***	-0.1428***	-0.0942***	-0.1246***	-0.1507***	-0.0881***	-0.2961***	-0.0901***	-0.1108***
	(0.0113)	(0.0194)	(0.0216)	(0.0264)	(0.0182)	(0.0258)	(0.0173)	(0.0113)	(0.0130)	(0.0124)	(0.0222)	(0.0198)	(0.0344)	(0.0327)	(0.0193)
β_{LK}	0.0014	0.0010	-0.0576***	0.0455***	0.0575***	0.0173**	-0.0019	-0.0367***	-0.0071	-0.0164***	-0.0248**	-0.0231**	-0.0281*	-0.0443***	-0.0420***
	(0.0048)	(0.0121)	(0.0139)	(0.0112)	(0.0084)	(0.0097)	(0.0103)	(0.0055)	(0.0058)	(0.0041)	(0.0101)	(0.0098)	(0.0157)	(0.0123)	(0.0080)
β_{LT}	-0.0002	-0.0123***	0.0051**	-0.0043	0.0117***	0.0006	0.0090***	0.0031***	0.0055***	-0.0111***	0.0016	-0.0017	-0.0082**	0.0015	-0.0100***
	(0.0009)	(0.0025)	(0.0024)	(0.0032)	(0.0024)	(0.0029)	(0.0022)	(0.0012)	(0.0016)	(0.0010)	(0.0022)	(0.0027)	(0.0028)	(0.0037)	(0.0023)
β_{KT}	0.0009	0.0097***	-0.0007	0.0080***	-0.0095***	-0.0041**	-0.0050***	-0.0003***	-0.0017*	0.0057***	0.0034*	-0.0004	0.0081***	0.0000	0.0059***
	(0.0009)	(0.0017)	(0.0018)	(0.0023)	(0.0015)	(0.0019)	(0.0015)	(0.0010)	(0.0010)	(0.0008)	(0.0018)	(0.0016)	(0.0021)	(0.0026)	(0.0017)
β_{LL}	0.1269***	0.1326***	0.1742***	0.1174***	0.0512**	0.0372**	0.1910***	0.1002***	0.0497***	0.0430***	0.1003***	0.1914***	0.1820***	0.2692***	0.1621***
	(0.0085)	(0.0212)	(0.0212)	(0.0254)	0.0226)	(0.0217)	(0.0204)	(0.0098)	(0.0132)	(0.0072)	(0.0167)	(0.0235)	(0.0238)	(0.0308)	(0.0191)
β_{KK}	0.0200***	0.0121**	0.0437***	0.0035	-0.0028	0.0082	0.0130*	0.0448***	0.0260***	0.0657***	0.0479***	0.0063	0.0335***	0.0292***	0.0170***
	(0.0033)	(0.0054)	(0.0109)	(0.0068)	(0.0037)	(0.0063)	(0.0078)	(0.0036)	(0.0029)	(0.0037)	(0.0066)	(0.0071)	(0.0072)	(0.0049)	(0.0032)
β_{TT}	0.0013***	0.0056***	0.0066***	0.0162***	0.0132***	0.0068***	0.0221***	0.0109***	0.0106***	0.0083***	0.0073***	0.0072***	0.0138***	0.0083***	0.0028***
	(0.0004)	(0.0009)	(0.0008)	(0.0011)	(0.0009)	(0.0015)	(0.0008)	(0.0005)	(0.0008)	(0.0004)	(0.0009)	(0.0011)	(0.0017)	(0.0017)	(0.0008)

Source: IOBE estimations.
Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A4 Translog production function estimations

(continued)

	10	20	22	23	25	41	45	47	52	55	56	63	68	71	86
constant	13.9778***	13.7720***	13.9375***	14.7697***	12.5660***	12.7361***	13.3907***	14.4190***	14.6031***	17.3126***	13.6046***	11.1198***	13.2746***	12.1104***	11.9950***
	(0.2933)	(0.5230)	(0.8745)	(0.5880)	(0.4167)	(0.5119)	(0.5860)	(0.2522)	(0.2279)	(0.4876)	(0.3543)	(0.5030)	(0.1173)	(0.4714)	(0.3828)
Uσ	-1.7264***	-1.6773***	-2.1505***	-1.3273	-1.8125***	-0.0696	-1.3128***	-1.8896***	-1.2785***	-1.9737***	-1.7743***	-1.3259***	-0.2327***	-0.9121***	-1.7989***
	(0.0311)	(0.0608)	(0.0668)	(0.0613)	(0.0590)	(0.0473)	(0.0413)	(0.0333)	(0.0446)	(0.0357)	(0.0612)	(0.0628)	(0.0524)	(0.0817)	(0.0553)
Vσ	-4.6640***	-4.4531***	-3.9824***	-3.0723***	-2.9893***	-2.1055***	-3.2865***	-3.5277***	-4.8275***	-5.4922***	-4.1991***	-2.7047***	-4.2852***	-2.4178***	-4.4103***
	(0.1043)	(0.1670)	(0.1297)	(0.1084)	(0.0766)	(0.0963)	(0.0886)	(0.0646)	(0.2032)	(0.4223)	(0.1624)	(0.1000)	(0.3625)	(0.1391)	(0.1433)
μ	1.0740***	0.8862***	0.7916***	0.7208***	0.7546***	0.9765***	1.0614***	1.2711***	1.3350***	1.2658***	0.7556***	0.9742***	1.6182***	0.8684***	0.7166***
	(0.0134)	(0.0168)	(0.0209)	(0.0230)	(0.0174)	(0.0257)	(0.0261)	(0.0181)	(0.0177)	(0.1315)	(0.0178)	(0.0394)	(0.0422)	(0.0312)	(0.0165)
σ_u	0.4218***	0.4323***	0.3412***	0.5150***	0.4040***	0.9658***	0.5187***	0.3888***	0.5277***	0.3728***	0.4118***	0.5153***	0.8902***	0.6338***	0.4068***
	(0.0066)	(0.0131)	(0.0114)	(0.0158)	(0.0119)	(0.0229)	(0.0107)	(0.0065)	(0.0118)	(0.0067)	(0.0126)	(0.0162)	(0.0233)	(0.0259)	(0.0112)
σ_v	0.0971***	0.1079***	0.1365***	0.2152***	0.2243***	0.3490***	0.1934***	0.1714***	0.0958***	0.0642***	0.1225***	0.2586***	0.1173***	0.2985***	0.1102***
	(0.0051)	(0.0090)	(0.0089)	(0.0117)	(0.0086)	(0.0168)	(0.0086)	(0.0055)	(0.0091)	(0.0136)	(0.0099)	(0.0129)	(0.0213)	(0.0208)	(0.0079)
λ	4.3440***	4.0063***	2.4991***	2.3928***	1.8011***	2.7676***	2.6827***	2.2684***	5.8972***	5.8082***	3.3615***	1.9925***	7.5859***	2.1230***	3.6903***
	(0.0100)	(0.0190)	(2.4991)	(0.0244)	(0.0182)	(0.0346)	(0.0166)	(0.0104)	(0.0175)	(0.0126)	(0.0189)	(0.0258)	(0.0359)	(0.0418)	(0.0160)
Observations	8,607	2,094	2,455	3,114	3,914	4,981	5,872	10,907	3,693	8,218	2,737	3,540	2,785	2,159	2,744
Firms	1,901	377	445	669	852	1,605	1,440	3,234	945	2,799	1,122	910	1,121	653	786
Wald χ^2	8,741.69	3,348.96	2,032.13	4,132.62	3,643.57	1,562.34	6,315.48	9,618.14	2,769.91	1,719.21	3,204.75	1,420.89	1,469.35	1,506.64	5,251.55
Prob>χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log-likelihood	-6,565.14	-1,481.74	-1,375.03	-2,942.99	-3,197.94	-7,885.91	-5,856.92	-9,795.48	-3,649.15	-7,048.44	-2,337.64	-3,724.69	-4,397.51	-2,626.79	-1,974.11
$\beta_T=\beta_{LK}=\beta_{LT}=\beta_{KT}=\beta_{LL}=\beta_{KK}=\beta_{TT}=0$															
χ^2	790.56	169.61	207.58	606.65	451.67	90.36	1,120.41	1,059.55	403.46	1,130.87	1,785.82	154.87	311.77	169.18	157.91
Prob>χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$\beta_T=\beta_{LT}=\beta_{KT}=\beta_{TT}=0$															
χ^2	26.49	102.45	102.18	333.50	273.10	35.76	919.64	740.84	196.59	522.40	119.98	59.51	130.60	26.40	43.57
Prob>χ^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Source: IOBE estimations.
Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

THE GREEK LABOUR MARKET BEFORE AND AFTER THE PANDEMIC: SLACK, TIGHTNESS AND SKILLS MISMATCH

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ABSTRACT

The Greek labour market recorded a significant improvement during the first half of 2022. This is encouraging and reflects, inter alia, output growth, the government support measures during the pandemic and the implementation of important structural reforms during the previous decade. However, in the current inflationary environment, the question that arises is whether the labour market is slack or tight and whether wage pressures may be emerging. This article draws on diverse sources of information on the labour market, in an attempt to shed some light on this question and examine how the Greek labour market evolved before and after the pandemic. In sum, unemployment remains high in Greece, well above the euro area average, and labour market slack is still evident by most measures. However, pockets of tightening are beginning to emerge at the sectoral level. Moreover, slack is declining at a fast pace, much faster than in the euro area, as suggested by the drop in unemployment over the past three years. The high share of long-term unemployment and the rather elevated estimates of efficient unemployment presented in this article also point in the same direction. Given the recent strong employment growth and the prospect of a significant need for additional labour over the coming years due to the implementation of the NextGenerationEU plan, labour market tightness could increase further. This concern is further compounded by extensive survey evidence of skills mismatches in the Greek labour market, which are known to adversely affect allocative efficiency and, thus, productivity. Looking ahead, it is important to pursue labour market policies aimed at increasing participation rates and upskilling or reskilling the labour force, including in particular the long-term unemployed.

Keywords: labour market; unemployment; Beveridge curve; tightness; slack

JEL classification: E24; J08; J21; J24; J31

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Η ΕΛΛΗΝΙΚΗ ΑΓΟΡΑ ΕΡΓΑΣΙΑΣ ΠΡΙΝ ΚΑΙ ΜΕΤΑ ΤΗΝ ΠΑΝΔΗΜΙΑ: ΧΑΛΑΡΟΤΗΤΑ, ΣΤΕΝΟΤΗΤΑ ΚΑΙ ΑΝΑΝΤΙΣΤΟΙΧΙΑ ΔΕΞΙΟΤΗΤΩΝ

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ΠΕΡΙΛΗΨΗ

Η ελληνική αγορά εργασίας κατέγραψε σημαντική βελτίωση κατά το πρώτο εξάμηνο του 2022. Αυτή η τάση αντικατοπτρίζει, μεταξύ άλλων, τον αυξημένο ρυθμό οικονομικής μεγέθυνσης, τα μέτρα στήριξης που έλαβε η ελληνική κυβέρνηση κατά την πανδημία και την εφαρμογή σημαντικών διαρθρωτικών μεταρρυθμίσεων κατά την προηγούμενη δεκαετία. Ωστόσο, στο τρέχον πληθωριστικό περιβάλλον, το ερώτημα που τίθεται είναι αν υπάρχει στενότητα (tightness) ή χαλαρότητα (slack) στην αγορά εργασίας και αν ενδέχεται να εμφανιστούν μισθολογικές πιέσεις. Το παρόν άρθρο αντλεί πληροφορίες για την αγορά εργασίας από διάφορες πηγές, σε μια προσπάθεια να διερευνήσει αυτό το ερώτημα και να εξετάσει πώς εξελίχθηκε η ελληνική αγορά εργασίας πριν και μετά την πανδημία. Εν ολίγοις, η ανεργία παραμένει υψηλή στην Ελλάδα, πολύ πάνω από το μέσο όρο της ζώνης του ευρώ, και εξακολουθεί να διαπιστώνεται χαλαρότητα στην αγορά εργασίας με βάση τα κύρια μεγέθη. Ωστόσο, αρχίζουν να παρατηρούνται κάποιες ενδείξεις στενότητας σε κλαδικό επίπεδο. Επιπλέον, η χαλαρότητα στην αγορά εργασίας μειώνεται με γρήγορους ρυθμούς, πολύ ταχύτερα από ό,τι στη ζώνη του ευρώ, όπως υποδηλώνει η πτώση της ανεργίας τα τελευταία τρία χρόνια. Το υψηλό ποσοστό της μακροχρόνιας ανεργίας και οι μάλλον αυξημένες εκτιμήσεις για την "αποτελεσματική ανεργία" (efficient unemployment) που παρουσιάζονται σε αυτό το άρθρο αποτελούν ενδείξεις προς την ίδια κατεύθυνση. Δεδομένης της πρόσφατης σημαντικής αύξησης της απασχόλησης, καθώς και της προοπτικής δημιουργίας νέων θέσεων εργασίας τα επόμενα χρόνια λόγω της εφαρμογής του σχεδίου NextGenerationEU, η στενότητα στην αγορά εργασίας ενδέχεται να αυξηθεί περαιτέρω. Η αναντιστοιχία δεξιοτήτων που διαπιστώνεται στην ελληνική αγορά εργασίας επιτείνει τον ως άνω προβληματισμό. Συνάγεται ότι είναι σημαντικό να επιδιωχθούν πολιτικές που στοχεύουν στην αύξηση του ποσοστού συμμετοχής στην αγορά εργασίας και στην εκπαίδευση ή επανειδίκευση του εργατικού δυναμικού, συμπεριλαμβανομένων ιδίως των μακροχρόνια ανέργων.

THE GREEK LABOUR MARKET BEFORE AND AFTER THE PANDEMIC: SLACK, TIGHTNESS AND SKILLS MISMATCH*

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1 INTRODUCTION

The Greek labour market recorded a significant improvement during the first half of 2022. Aggregate employment increased by 9% year-on-year (y-o-y), while dependent employment increased by 12%. Almost all sectors recorded positive employment growth rates and especially the tourism, retail, manufacturing and construction sectors. Moreover, the unemployment rate declined to 11.8% in September, a level not seen since 2010, though still well above the euro area average.

This recent strong performance follows a period of notable labour market resilience during the pandemic. While many firms were forced to suspend their operation in 2020, triggering a deep recession, the number of persons employed declined by much less than economic activity or hours worked, and less than in the euro area, largely due to the generous support measures of the Greek government.

In sum, recent labour market developments are encouraging and reflect, inter alia, output growth, the pandemic-related support measures and the implementation of important structural reforms during the previous decade. However, in the current inflationary environment, the question that arises is whether the labour market is slack or tight and whether wage pressures may be emerging. This article draws on diverse sources of information on the labour market, in an attempt to shed some light on this question and examine how the Greek labour market evolved before and after the pandemic.

Delving deeper into the recent sharp decline in unemployment, in Section 2 we show that it is not driven by lower labour force participation. The participation of workers aged 15-74

* 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.

has risen over the past decade and is as high now as it was in 2010. This increase is not merely a cyclical phenomenon but rather a larger trend, underpinned by the rising participation of women and workers above prime age. The employment-to-population ratio is also on the rise. However, it should be noted that the labour force participation has been growing at a slower pace over recent years and, in 2022, remains almost 5 percentage points lower than the euro area average, suggesting that, recent improvements notwithstanding, the Greek labour market is still some way away from fully utilising its human capital.

Labour market slack, as measured by the fraction of the extended labour force not fully utilised in the labour market, but willing to offer more, improved the most in Greece among euro area countries following the pandemic, as outlined in Section 3, declining from 24.3% in the fourth quarter of 2019 to 18% in the second quarter of 2022. Nonetheless, it remains the third highest in the euro area on account of Greece's high unemployment rate, indicating the lingering presence of slack in the labour market.

Similarly, the job vacancy rate, a measure of labour market tightness which is discussed in Section 4, declined in Greece before the pandemic and has been increasing since the first quarter of 2021. A similar pattern was recorded in the euro area, where the pandemic prompted a sharp temporary fall in job vacancy rates. By this measure, there has been a tightening in the Greek labour market in recent years. Still, the job vacancy rate in Greece remains much lower than that of the euro area, indicating, yet again, that the Greek labour market is less tight than the euro area average.

On the other hand, it is notable that Greece has the highest long-term unemployment rate among euro area countries, standing at 7.8% in the second quarter of 2022 compared to a 2.7% euro area average, with 63% of all unemployed in Greece being long-term unemployed. While a substantial decline in the long-term unemployment rate has been achieved in recent years, the high share of long-term unemployed and the known difficulty in re-employing this cohort imply that slack in the Greek labour market may effectively be lower, and closer to the euro area average, than indicated by some of the aforementioned metrics.

Turning to a more model-based analysis in Section 5, an examination of the Greek Beveridge curve from 2009 onwards reveals similar patterns to those reported in the literature, namely an increase in tightness (the ratio of vacancies to unemployment) as unemployment declines. However, in the case of Greece, there doesn't seem to be evidence of a concurrent decrease in labour market efficiency, i.e. an outward shift of the Beveridge curve, as is often the case following a recession. Indeed, the improvement in the Greek labour market is a result of both a decrease in the separation rate and an increase in the job finding rate. This may reflect the positive impact of the structural labour market reforms undertaken over the past decade. Higher tightness with broadly constant labour market efficiency could also reflect an increase in productivity, which is known to induce firms to increase vacancies and hence employment. While higher productivity could imply an upward pressure on wages, it would allow for wage gains without disrupting employment gains.

As a follow-up, we explore the novel notion of efficient unemployment, which has not previously been considered for Greece. It is defined as the rate of unemployment which minimises the sum of unemployment and vacancy creation, subject to the Beveridge curve, to acknowledge that it is not possible to reduce both unemployment and vacancies to zero at the same time. We estimate the slope of the Greek Beveridge curve under alternative assumptions and use its elasticity to calculate efficient unemployment for Greece for the period from 2010 to date. We show that, at the current juncture, efficient unemployment is below, but close to, the current value of headline unemployment for all plausible values of the Beveridge elasticity, indicating that there still exists slack in the labour market, albeit fast declining.

Turning to sectoral micro-level evidence in Section 6, the ERGANI data indicate that the post-COVID period of 2021 has been characterised by robust employment growth across most major sectors. For most sectors, the wages of new hires and their relative wages compared to those of incumbent workers do not show any significant upward trend. Thus, on balance, wage growth data do not show signs of a general tightness in the labour market. The Construction, Hotels & Restaurants and Other Services sectors are exceptions, exhibiting an upward trend in wages of new hires as well as in employment flows, which may be indicative of emerging market pressures.

Finally, a discussion of labour market developments would be incomplete without considering skills availability and mismatch. As discussed in Section 7, an efficient allocation of workers across tasks is particularly important when the aggregate skills supply is relatively limited, as is the case with Greece. Persistent skill 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. We find that overskill mismatch plays an important role for productivity, and overskilling in professional occupations, where Greece scores especially poorly, is a major drag.

To sum up, unemployment remains high in Greece, well above the euro area average, and labour market slack is still evident by most measures. However, pockets of tightening are beginning to emerge at the sectoral level. Moreover, slack is declining at a fast pace, much faster than in the euro area, as suggested by the drop in unemployment over the past three years. In addition, long-term unemployment in Greece is high, suggesting that, at some point, it may become difficult to reduce the unemployment rate below the level of long-term unemployment, which currently stands at about 7%. Subtracting long-term unemployment from the measure of slack suggests that slack in Greece may be closer to the euro area average than indicated by the baseline measure. Estimates of efficient unemployment are also high, hovering around 8-10%. With unemployment currently below 12%, this means that the unemployment gap, i.e. the distance to equilibrium unemployment, is closing. Given the recent strong employment growth and the prospect of a significant need for additional labour due to NextGenerationEU (whose implementation will require a projected additional 200,000 jobs by 2026, according to the National Recovery and Resilience Plan), labour market tightness could increase significantly over the coming years.

This analysis has important policy implications. Notably, looking ahead, it is particularly important to pursue labour market policies aimed at increasing participation rates and upskilling or reskilling the labour force, including in particular the long-term unemployed. The ongoing adverse demographic developments and the recent exodus of young highly skilled workers following the sovereign debt crisis also underline the pivotal role of active labour market policies. Carefully designed policies to enhance education and skills acquisition would 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 such policies will help ensure that technology adoption has a positive impact on productivity, output growth and employment.

In this spirit, the National Recovery and Resilience Plan includes reforms which will foster labour market activation and upskilling. Moreover, the timely absorption of the NextGenerationEU funds and the full implementation of the planned investments and structural reforms will enhance the economy's innovation capacity and create new high-skilled jobs, hopefully contributing to a reversal of the previous decade's brain drain. In light of the analysis presented in this article, optimising the use of the NextGenerationEU funds and designing targeted labour market policies will be key to ensuring robust employment growth, high labour force participation and, ultimately, strong and sustainable economic growth over the medium-term horizon.

2 RECENT DEVELOPMENTS AND LONG-RUN TRENDS IN THE GREEK LABOUR MARKET

2.1 EMPLOYMENT AND UNEMPLOYMENT

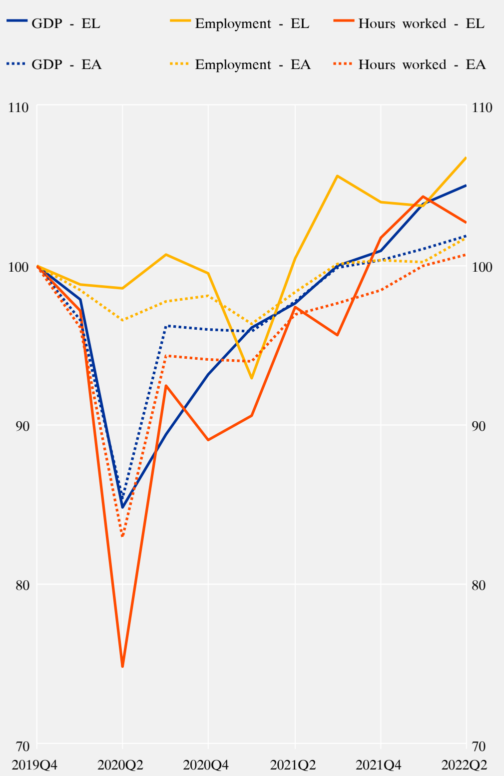
The COVID-19 pandemic led to a significant recession in 2020, as many firms, especially in the tourism sector, suspended their operation. However, due to the support measures of the Greek government, the number of persons employed declined much less compared to economic activity and hours worked. Chart 1 shows the evolution of economic activity, aggregate employment and hours worked in Greece and the euro area. In the second quarter of 2020, when the first lockdown occurred, both GDP and hours worked declined more in Greece compared to the euro area, while aggregate employment dropped comparatively less. Since the second quarter of 2021, when most of the COVID-19 containment measures were lifted, employment growth has been strong and has reverted to pre-pandemic levels by achieving higher growth rates compared to the euro area. To a large extent, the strong rebound of the labour market after the lifting of the majority of COVID-19-related measures is likely due, among other things, to the implementation of important structural reforms during the previous decade, which made the labour market more flexible.[1]

During the first half of 2022, the labour market improved significantly as the strong demand for tourism services led to increased hirings in Hotels & Restaurants. As a result, aggregate employment increased by 9.0% y-o-y in the first half of 2022, while dependent employment increased even more, by 12.0% y-o-y. Almost all sectors recorded positive employment growth rates and especially the tourism sector, retail trade, manufacturing and construction. In addition, the unemployment rate declined to 13.1% from 16.5% in the first half of 2022, and to 11.8% in September 2022, reaching a level not seen since 2010.

The drop in unemployment (Chart 2) was more significant for the most vulnerable social groups, especially for young people[2] and for

Chart 1 Evolution of GDP, employment and hours worked in Greece and the euro area

(index: 2019:Q4=100, people aged 15-74, seasonally adjusted)



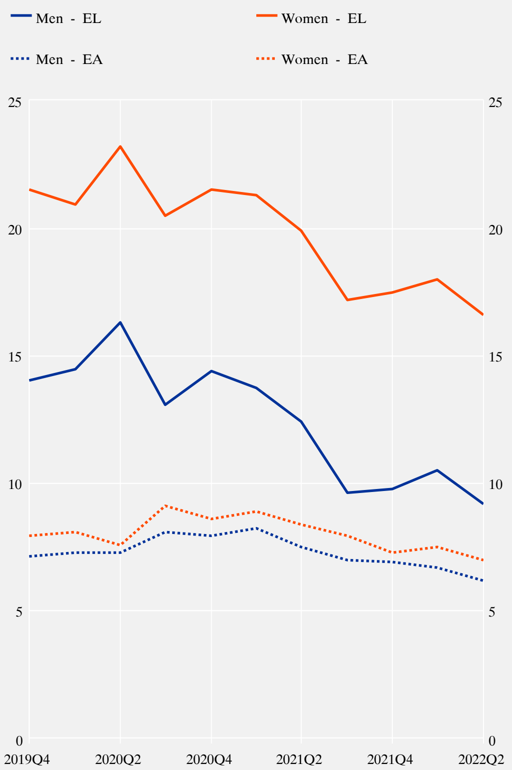
Source: Eurostat.
Note: EL = Greece, EA = euro area.

1 The extensive 2010-2014 labour market structural reforms, including provisions concerning collective dismissals, the institutional framework for unions and collective agreements, the promotion of flexible forms of employment, the decentralisation of the wage setting process, as well as the statutory minimum wage reductions, raised flexibility, contributed to the strong moderation of wage costs and increased the resilience of employment to adverse economic shocks.

2 30.4% in the first half of 2022 compared to 39.0% in the first half of 2021 for people aged 20-24, and 20.4% in the first half of 2022 compared to 29.1% in the first half of 2021 for people aged 25-29.

Chart 2 Unemployment rate in Greece and the euro area by gender

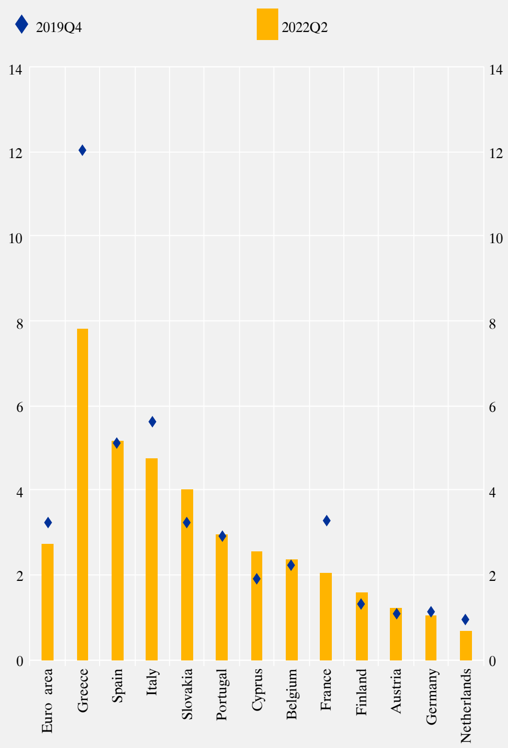
(% of the labour force, people aged 15-74)



Source: Eurostat.
Note: EL = Greece, EA = euro area.

Chart 3 Long-term unemployment rate in the euro area

(% of the labour force, people aged 15-74)



Source: Eurostat.
Note: Only Member States with available data for 2022:Q2 are presented.

women.[3] At the same time, the labour force increased significantly (4.9% y-o-y in the first half of 2022), as people who were reluctant to enter the labour force due to health concerns and the need to take care of their vulnerable relatives were again available in the labour market.

Nevertheless, while the unemployment rate has declined for both men and women, the distance from the euro area average remains large. The persistently high unemployment in recent years, despite a long-term decline from its peak, is likely to have exacerbated the problem of mismatch between jobs demanded and offered, as a significant part of the workforce has lost some of its skills.[4] In addition, factors such as population ageing, retirement of workers and labour migration during the crisis years have led to shortages of both low- and high-skilled workers.

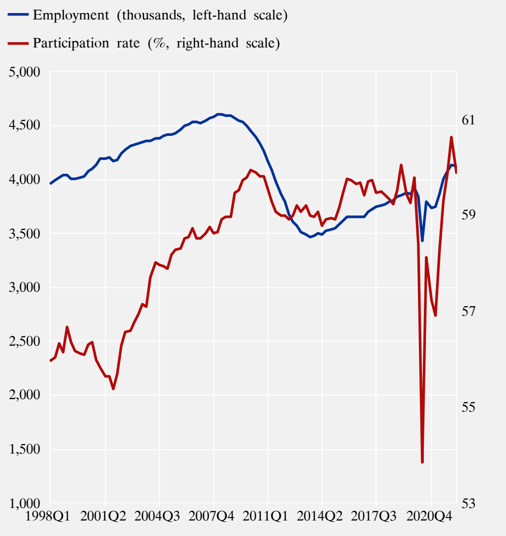
It is notable, however, that Greece has the highest long-term unemployment rate (ratio of persons unemployed over 12 months to labour force) among euro area countries, standing at 7.8% in the second quarter of 2022, compared to 2.7% on average in the euro area (see Chart 3), despite the large improvement since 2019.[5]

2.2 PARTICIPATION RATES

The recent sharp decline in unemployment is not simply due to lower participation, as one could have feared due to the pandemic, and as was the case in other countries (e.g. in the

3 17.3% in the first half of 2022 compared to 20.6% in the first half of 2021.
4 See Section 6 for a thorough analysis of mismatch in the Greek labour market.
5 Long-term unemployment amounts to 62.6% of total unemployment in Greece compared to 41.7% in the euro area.

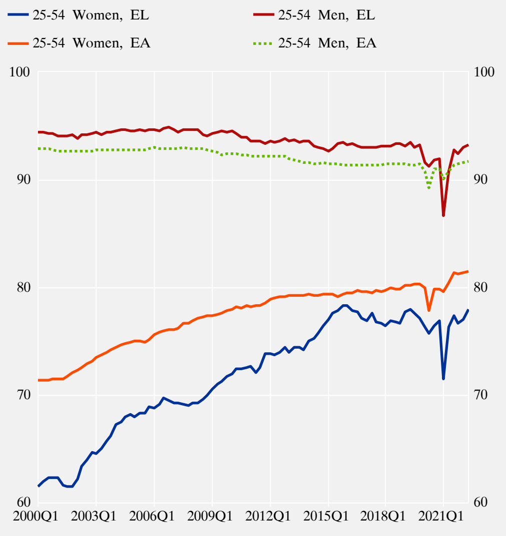
Chart 4 Employment and participation rate in Greece



Sources: LFS and Eurostat.

Chart 5 Prime-age participation rate in Greece and the euro area

(%)



Sources: LFS and Eurostat.
Note: EL = Greece, EA = euro area.

United States and the United Kingdom, though not in the EU). The participation of workers aged 15-74 (Chart 4) is as high now as it was in 2010; following a predictable fall at the outset of the pandemic, it continued its upward trajectory, reaching 60.2% (for the 15-74 age group) in the third quarter of 2021, an all-time high. As a result, total employment passed the 4 million mark in the third quarter of 2021 for the first time since 2011.

The gains in participation have come primarily from two sources: higher participation of workers above prime age and women. As is common in other advanced economies, the participation of prime-age (aged 25-54) men has fallen slightly over the past two decades (Chart 5), by approximately one percentage point. By contrast, the participation of prime-age women has kept rising and is now at 78%, over 15 percentage points higher than in the early 2000s. This likely reflects a combination of demographic and social factors, as younger women, with a much higher tendency to work outside the home, replace older cohorts. The participation of prime-age women seems to have plateaued in recent years, and the pandemic does not seem to have changed this. Interestingly, participation of prime-age men in Greece has been consistently slightly higher than in the rest of the euro area for the past two decades; for women, it has been lower, possibly reflecting, inter alia, the relative inadequacy of support measures for motherhood, though the difference has shrunk in recent years.

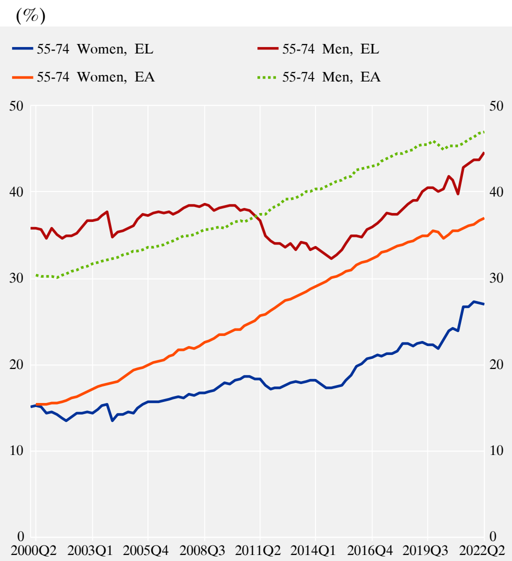
As for older workers (aged 55-74), gains have been more modest but are just as important. The participation of the 55-74 age cohort has risen from 27% in 2008 to 34% in 2021 (Chart 6). The gains are similar for both men and women, though for men participation is almost twice as high for this cohort. It is likely that participation gains for this group are the result of the various reforms that took place, which discourage early retirement; participation for these groups is likely to increase further, as cohorts benefitting from early retirement policies are replaced by younger ones. Newer policies, which substantially lower pension reductions for working pensioners, are expected to further fuel this trend. On the other hand, the pandemic may have also hastened retirement for these workers, as was the case in other countries, so perhaps these trends may have been delayed. The increase in the participation rate, particularly because it is not merely a cyclical phenomenon but rather part of a larger trend, is encouraging regarding the growth potential of the labour market. The participation of older men was higher than in the rest of the euro area until the crisis, perhaps due to the higher rate of self-employment, falling substantially below at the onset of the crisis due to early retirements. Participation of older women, however, remains substantially lower.

Finally, Chart 7 shows the employment-to-population ratio for the 15-74 age group, a reasonably model-free metric of tightness of the labour market. It has risen substantially from its low of the previous decade and has resumed its pre-pandemic trend as of 2022. On the other hand, it is still below its pre-crisis level, suggesting that further gains may be possible due to the various reforms enacted during the sovereign debt crisis to raise participation, coupled with rising longevity and reductions in early retirements.

As such, even though the working age population and the labour force may have shrunk over the past fifteen years, the higher participation rate means that the new equilibrium may allow for a higher employment-to-population ratio. All in all, this graphical evidence suggests that, despite having improved, the Greek labour market is still some way away from fully utilising its human capital.

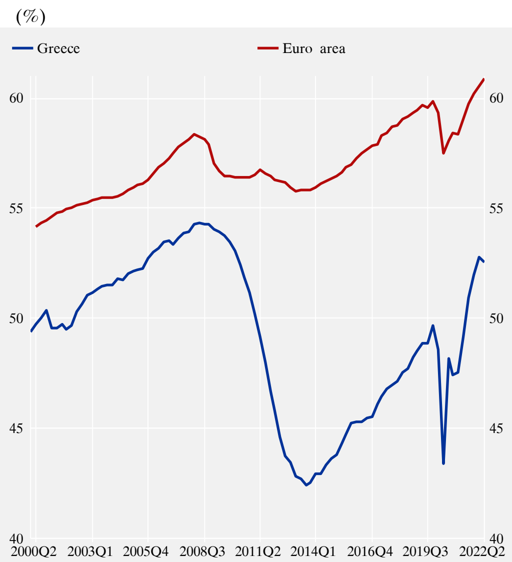
Furthermore, the aforementioned analysis notwithstanding, the overall labour force participation rate in 2022 remained almost 5 percentage points lower than the euro area average (Chart 8). This is a perennial problem of the Greek economy as the lack of support measures for motherhood discourages women from entering the labour market, while the family support net in the Greek society is a disincentive for young people to seek a job. On this front, active labour market policies

Chart 6 Participation rates for workers aged 55-74 in Greece and the euro area



Sources: LFS and Eurostat.
Note: EL = Greece, EA = euro area.

Chart 7 Employment-to-population ratio in Greece and the euro area

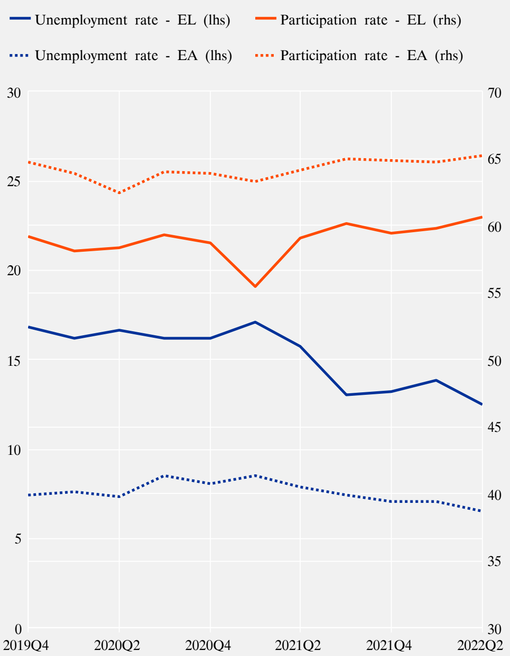


Sources: LFS and Eurostat.

that would support employment, increase skills and enhance the experience of workers, especially those most vulnerable, would increase attachment to the labour market and

Chart 8 Unemployment rate and labour force participation rate

(%, people aged 15-74)



Source: Eurostat.
Note: EL = Greece, EA = euro area.

eventually result in higher employment and participation rates. In light of the adverse demographic developments and the exodus of young skilled workers with enhanced human capital, especially after the recent economic crisis, the role of active labour market policies along with labour market reforms seems to be crucial.

3 LABOUR MARKET SLACK IN THE GREEK ECONOMY

Further to the unemployment rate, another indicator that is widely used to examine slack in the labour market is related to a wider notion of underutilisation. Indeed, to better reflect the unmet need for employment, labour market slack consists of all people who are not fully utilised in the labour market, but express their willingness to offer more. Following Eurostat, there are four different groups that belong to the above definition:[6]

- unemployed people;
- underemployed part-time workers who want to work more;
- people who are available to work but are not looking for work;
- people who are looking for work but are not available for work.

The first two groups belong to the definition of the labour force, but the last two belong to the definition of inactive persons and are outside the labour force. For the analysis of labour market slack, we use the "extended labour force", which is the sum of labour force plus the two last groups.

Chart 9 shows labour market slack as a share of the extended labour force for the euro area Member States and its decomposition for the second quarter of 2022. In addition, the aggregate share for the fourth quarter of 2019 (the last quarter before the outbreak of COVID-19 pandemic) is presented.

In the second quarter of 2022, euro area labour market slack, as measured by the same metric, stood at around 13.5% of the extended labour force compared to 15.0% before the outbreak of the pandemic. Unemployment accounts for half of this percentage, while the rest is divided between people who are available but not seeking a job and people who are seeking a job but are not available. Greece had the third largest share, mainly due to the high unemployment rate (11.8% of the extended labour force), behind Spain and Italy, while in the fourth quarter of 2019 it registered the highest rate. The second largest contributor was underemployed part-time workers (3.4% of the extended labour force), as many employees work part-time, while they

6 According to Eurostat, "persons seeking work but not immediately available, consists mostly of people who do not qualify as unemployed because of their limited availability to start in a new job, despite their being jobseekers". For more details, see https://op.europa.eu/en/publication-detail/-/publication/30df990e-7eea-4dbb-8846-7e9808e3bb65.

Chart 9 Labour market slack in the euro area (2022:Q2)

(% of the extended labour force, people aged 15-74, seasonally adjusted data)

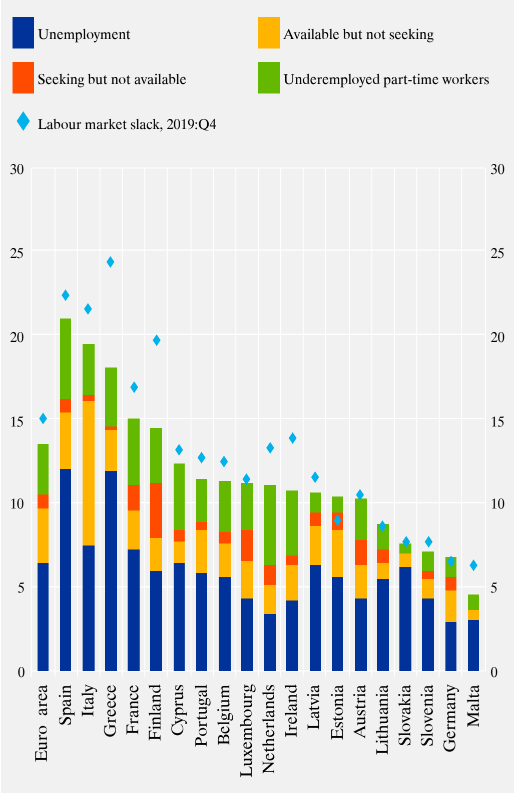
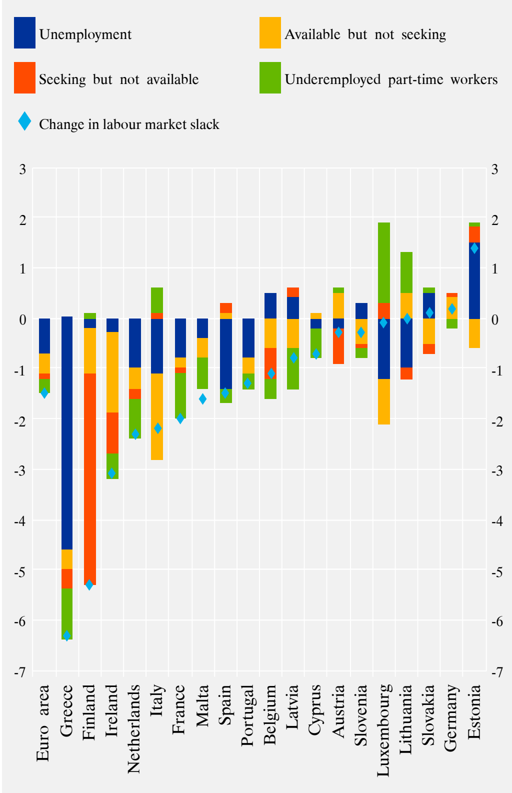


Chart 10 Change in labour market slack in the euro area (2019:Q4-2022:Q2)

(percentage points, people aged 15-74, seasonally adjusted data)



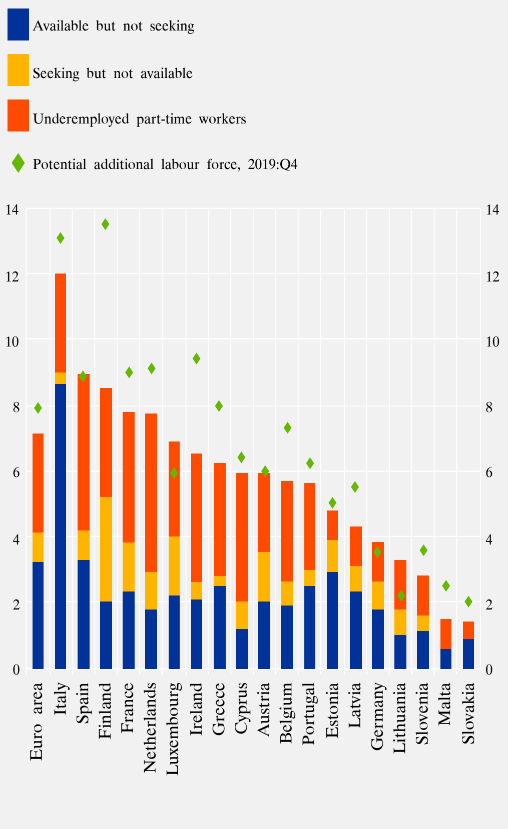
want to work more hours and increase their income. The third largest category is people who are available to work but are not seeking employment (2.5% of the extended labour force); these people are usually those discouraged from a long absence from the labour market and are not actively searching for a new job. The long absence from the labour market often leads to a deterioration of their skills. If we examine the share of people who are available but not seeking a job over time, the highest rates were observed during the periods of lockdown, i.e. in the second quarter of 2020 (4.6% of the extended labour force), in the fourth quarter of 2020 (5.1% of the extended labour force) and in the first quarter of 2021 (6.4% of the extended labour force), as they probably had to take care of the children who were attending school at home and elderly people.

Labour market slack improved in almost all Member States (with the exception of Estonia, Slovakia and Germany) after the pandemic. The most significant improvement was realised in Greece, as this share of the extended labour force declined from 24.3% in the fourth quarter of 2019 to 18.0% in the second quarter of 2022. Chart 10 shows the differences between the two periods. Labour market slack declined by 6.3 percentage points in Greece, compared to 1.5 percentage points in the euro area; all four components contributed to the decline, though the drop in the unemployment rate was the main factor.

Excluding the unemployment rate, the remaining three components comprise the potential additional labour force (Chart 11). In this case, the share of Greece is lower relative to the euro area average (6.2% compared to 7.1% in

Chart 11 Shares of the potential additional labour force in the euro area (2022:Q2)

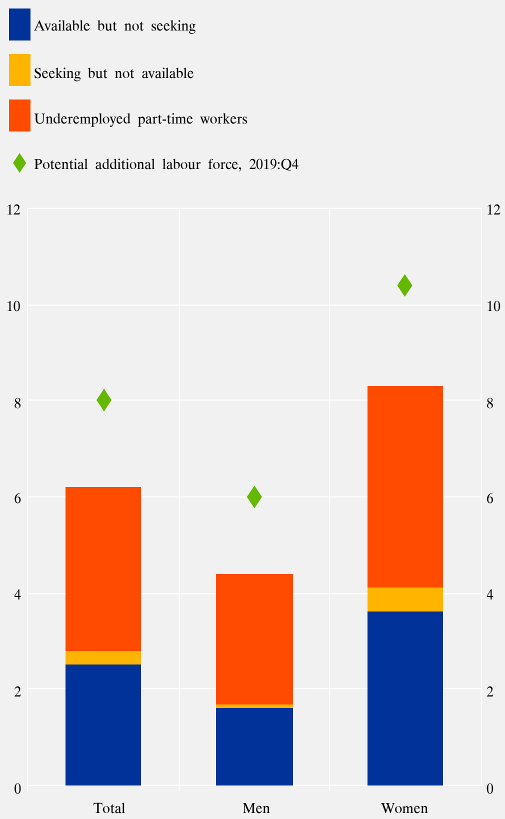
(% of the extended labour force, people aged 15-74, seasonally adjusted data)



Source: Eurostat.

Chart 12 Shares of the potential additional labour force in Greece by gender (2022:Q2)

(% of the extended labour force, people aged 15-74, seasonally adjusted data)



Source: Eurostat.

the euro area). In addition, the share of people who are seeking a job, but are not available, is the third lowest across euro area Member States.

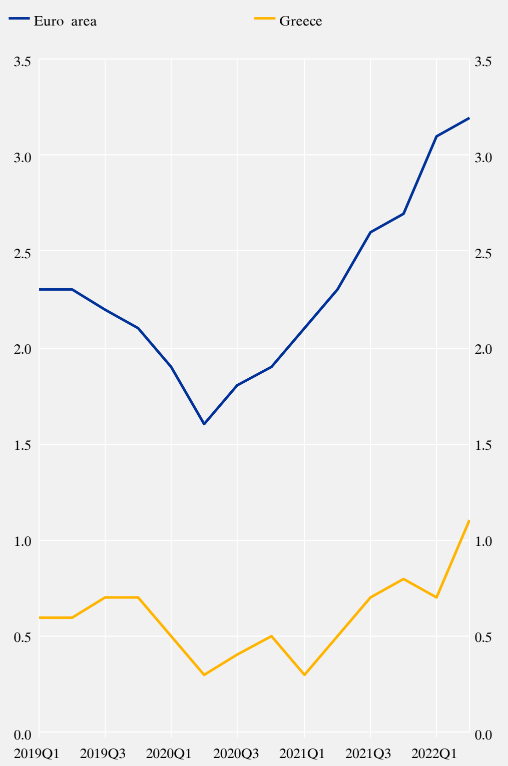
The share of potential additional labour force is almost double for women (8.3% of the extended labour force) compared to men (4.4% of the extended labour force) (Chart 12). Even though this share has declined compared to the fourth quarter of 2019, it remains high. The share of available but not seeking women (discouraged workers) is more than double compared with the share of men. Additional reforms and the implementation of more targeted measures to increase female participation and attachment to the labour market should be considered. These include easier access to nurseries for young children and care homes for the elderly, subsidies for hiring women, (re)training programmes and policies for enhancing their skills. Such policies would encourage women to join the labour force and increase their activity rates and thus, subsequently, total labour force participation.

4 TIGHTNESS IN THE GREEK LABOUR MARKET: JOB VACANCY RATES AND UNEMPLOYMENT

Labour market tightness reflects the relative abundance of vacancies as compared to those seeking for a job. The pandemic resulted in a

Chart 13 Job vacancy rates

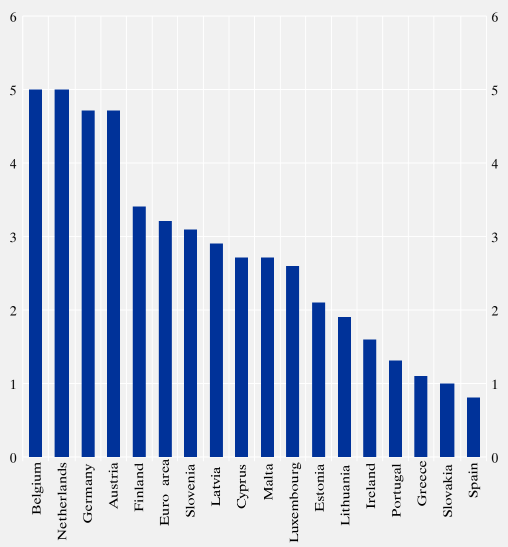
(%, seasonally adjusted data)



Source: Eurostat.
Note: Job vacancy rates cover NACE Rev. 2 sections B to S.

Chart 14 Job vacancy rates in the euro area (2022:Q2)

(%, seasonally adjusted data)



Source: Eurostat.

sharp fall in job vacancy rates[7] in the euro area, followed by a recovery. In Greece, despite lower job vacancy rates compared to the euro area, the job vacancy rate declined before the pandemic, while it increased from the first quarter of 2021, reaching 1.1% in the second quarter of 2022 (Chart 13).

Among the euro area Member States for which comparable data are available,[8] there are countries with a high job vacancy rate, a few countries with a low rate, while the majority of them are at a medium level (Chart 14). In the first group belong the Netherlands (5.0%), Belgium (5.0%), Germany (4.7%) and Austria (4.7%). Greece is among the countries with the lowest job vacancy rate, along with Spain (1.1% and 0.8%, each).

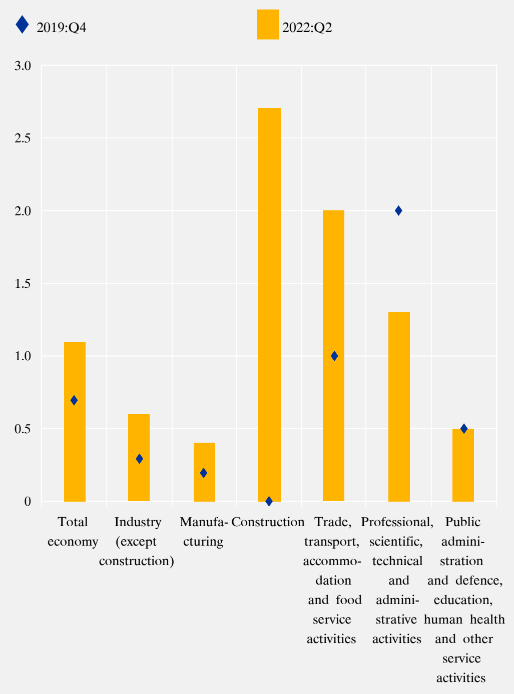
However, compared with the fourth quarter of 2019 (the last quarter before the outbreak of COVID-19), Greece's job vacancy rate has increased by 0.5 percentage points, albeit to a lesser extent than the euro area average (1.1 percentage points). In the majority of the countries, the job vacancy rate increased, with changes ranging between 0.1 and 1.7 percentage points. The largest increases were observed in the Netherlands (1.7 percentage points), Austria, Belgium and Germany (1.6 percentage points, respectively).

The analysis of job vacancy rates by sector of economic activity raises important issues regarding the presence of heterogeneity in this respect in the Greek labour market. In particular, in the second quarter of 2022 there were sectors that reported high vacancy rates such as construction and trade, transport and accommodation (2.7% and 2.0%, respectively), presenting at the same time the highest rate of change compared to the last quarter of 2019.

7 The job vacancy rate (JVR) measures the proportion of total job posts that are vacant, expressed as a percentage, i.e. JVR = (number of job vacancies)*100/(number of occupied posts + number of job vacancies).
8 Data for France and Italy are not strictly comparable. Particularly in France, only business units with 10 employees or more are surveyed. Moreover, in the case of Public Administration, Education and Human Health (NACE Rev. 2 sections O, P and Q, respectively), public institutions are not covered in France and Italy.

Chart 15 Job vacancy rates by sector in Greece (2019:Q4-2022:Q2)

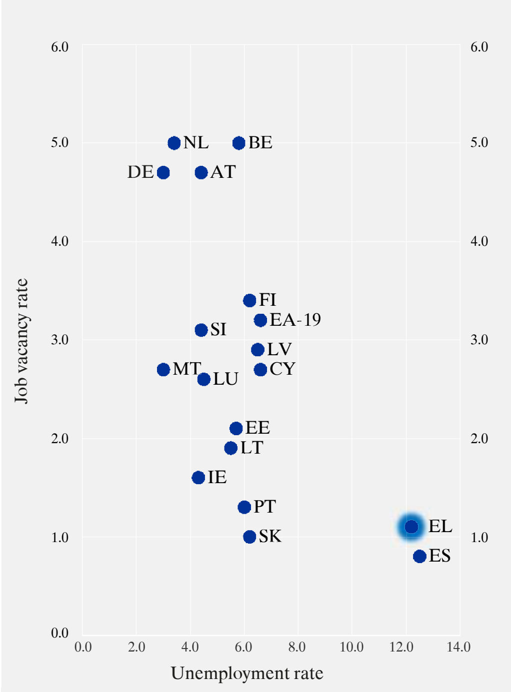
(%, seasonally adjusted data)



Source: Eurostat.

Chart 16 Job vacancy and unemployment rates in the euro area (2022:Q2)

(%, seasonally adjusted data)



Source: Eurostat.

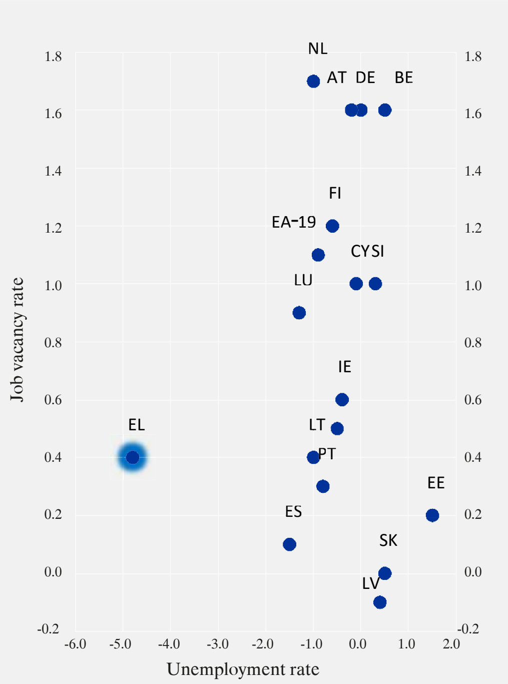
In particular, tourism-related activities showed a sharp increase of the job vacancy rate, reaching 8.5% in the second quarter of 2022 from 2.9% in the fourth quarter of 2019. On the other hand, there were sectors like manufacturing and industry which, despite starting from low job vacancy rates, recorded mild increases. In contrast, in services, i.e. the public administration, education and health sectors, the job vacancy rates remained flat compared to the fourth quarter of 2019. Overall, the labour market appears to be tighter than before the pandemic, with industry, trade, tourism and construction revealing higher tightness compared to services (Chart 15).

Important issues of heterogeneity across euro area Member States appear when analysing the job vacancy rate in combination with the unemployment rate. Particularly, there are countries with a low unemployment rate and a high job vacancy rate, such as Germany, Belgium, the Netherlands and Austria, while others show the opposite picture. Greece, with an unemployment rate of 12.2% in the second quarter of 2022 and a job vacancy rate of 1.1%, belongs to the group of countries with a high unemployment rate and a low job vacancy rate, pointing to labour market slack (Chart 16).

However, looking at the evolution of the labour market during the pre- and post-COVID-19 periods, Greece has made significant progress, as it recorded the largest reduction in the unemployment rate (-4.8 percentage points), while in the majority of the euro area countries the unemployment rate decreased by less than 1 percentage point, with a simultaneous increase in the job vacancy rate (Chart 17). This suggests that after the pandemic Greece is characterised by remaining labour market slack and an increase in labour market tightness.

Chart 17 Changes in job vacancy rates and unemployment rates in the euro area (2019:Q4-2022:Q2)

(%, seasonally adjusted data)



Source: Eurostat.

5 INSIGHTS FROM THE BEVERIDGE CURVE

5.1 THE GREEK BEVERIDGE CURVE

To delve deeper into the relationship between job vacancies and unemployment and its evolution over time, one needs to consider the Beveridge curve.[9] The Beveridge curve is an empirical relationship between the vacancy (v) and unemployment rates (u); a negative slope of the curve in the v-u space is a robust empirical feature of market economies, and useful for drawing conclusions about labour market tightness. It is an integral part of standard macroeconomic analyses of the labour market, principally the search and matching framework (see Pissarides et al. 2000).[10]

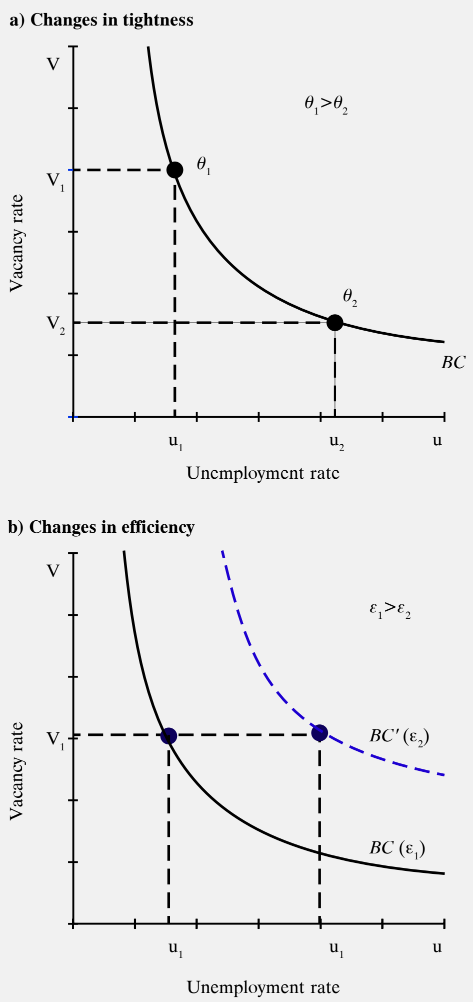
Intuitively, when the vacancy rate is low, demand for new workers is low relative to the labour force, so it is harder for unemployed workers to find jobs. In a dynamic labour market with constant churn of workers, this means that unemployment is higher. As vacancies increase, the unemployment rate will decrease. The higher the economy is on the v-u space, the tighter the labour market is; $\theta=v/u$ is labour market tightness. In tight labour markets, it is harder for firms to fill vacancies, and so vacancies will remain unfilled for longer. As the search for workers is costly, a high θ is typically thought of as a useful summary statistic of the labour market situation.[11]

While movements along the Beveridge curve reflect changes in tightness, shifts in the Beveridge curve reflect changes in matching efficiency, ε. The rate of matches in the labour market is determined by the matching function, $m(\theta, \varepsilon)$; m is falling in θ, as fewer matches per vacancy are made in tight labour markets, and rising in ε. A less efficient labour market will have fewer matches for each level of tightness; put another way, it implies a higher number of vacancies to sustain a given unemployment rate. As such, a shift out of the Beveridge curve is associated with a less efficient labour market. Labour market efficiency can depend on a variety of factors, most prominently frictions in the allocation of workers and the matching process itself (how easy it is to access vacancies, screen candidates, etc.), as well as search effort and the propensity of firms to fill vacancies. The two main forces behind the Beveridge curve, efficiency and tightness, are depicted in Chart 18.

Labour market efficiency typically falls after recessions. The Beveridge curve shifts out when unemployment reaches its local maximum; vacancies naturally precede job fillings as firms start to look for workers more intensively, so the reduction in unemployment will lag the rise in vacancies. As the economy improves and unemployment falls, labour mar-

9 Note the different definitions of the vacancy rate. In the US it is defined as vacancies over employment, and in Europe as vacancies over the labour force (unemployed and occupied posts).
10 Pissarides Committee, "Development Plan for the Greek Economy", 2020.
11 If search were costless, firms could post high numbers of vacancies irrespective of labour market conditions, making v/u an inappropriate measure of tightness.

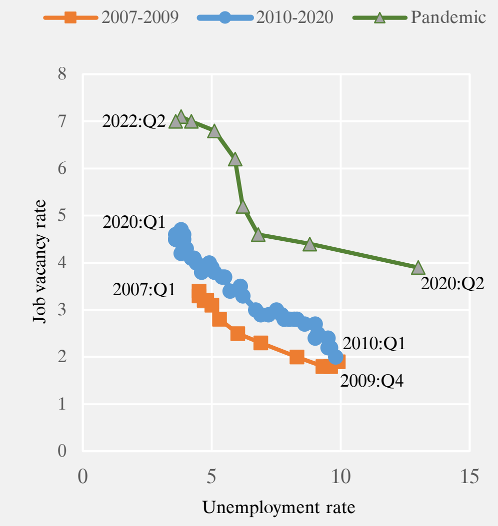
Chart 18 Movements along and shifts in the Beveridge curve



Source: Consolo, A. and A. Dias da Silva (2019), "The euro area labour market through the lens of the Beveridge curve", *ECB Economic Bulletin*, Issue 4.

Chart 19 The Beveridge curve in the United States

(%)



Source: FRED, Bank of Greece calculations.
Note: The vacancy rate is defined as vacancies to employment.

ket efficiency is gradually restored and the curve shifts in. This cyclical relationship between vacancies and unemployment gives rise to a banana-shaped chart in the *v-u* space and provides a good representation of advanced economy labour markets during the 2010s recovery. Chart 19 depicts this pattern for the US for illustration purposes. The banana-shape formed by the blue and orange segments of the US Beveridge curve never fully closes, indicating that pre-crisis efficiency was never attained again. The euro area Beveridge curve shows a similar relationship.[12]

The Beveridge curve for the Greek labour market followed similar dynamics during and following the financial crisis. This is shown in Chart 20, separately for all firms in the business sector (excluding the primary sector and households) and firms with over 10 employees.[13] There was a steep movement along the Beveridge curve while unemployment was rising, until around 2013. As unemployment stabilised, vacancies started to rise, but it took some time for unemployment to start falling, leading to a temporary shift out. Interestingly though, the recovery was not followed by movements along a new, less efficient, curve, as was the case in the US or the rest of the euro area.

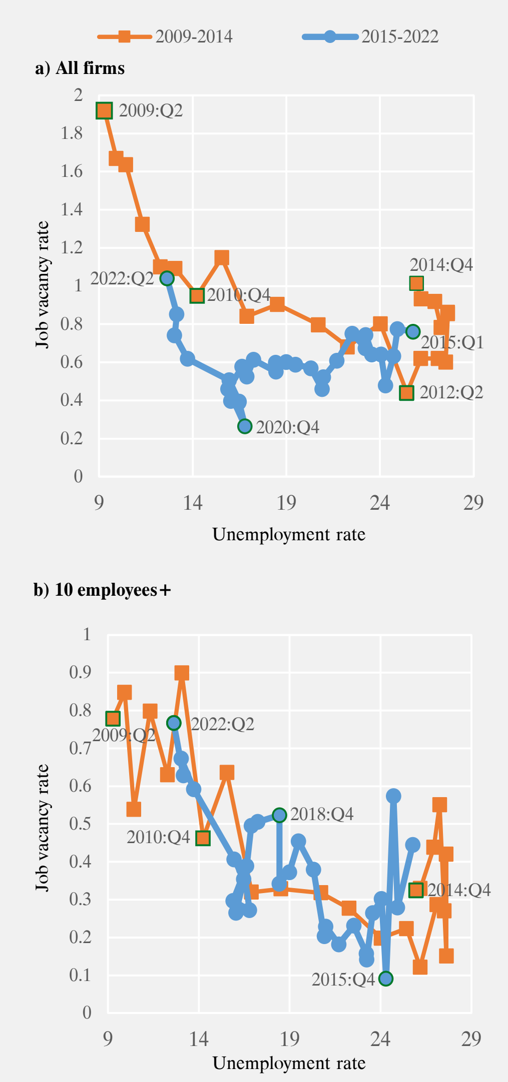
The picture is somewhat different depending on the data used. With vacancy data for all

12 Consolo, A. and A. Dias da Silva (2019), "The euro area labour market through the lens of the Beveridge curve", ECB, *Economic Bulletin*, Issue 4.

13 The vacancy rate has been seasonally adjusted by Bank of Greece staff, as the official seasonally adjusted series is much shorter. A non-seasonally adjusted Beveridge curve gives a very similar result qualitatively.

Chart 20 The Beveridge curve in Greece

(%)



Sources: LFS, Eurostat and Bank of Greece calculations.
Note: The vacancy rate is defined as vacancies to the sum of vacancies and occupied positions. The top panel shows vacancies for all firms; the bottom panel shows vacancies for firms with over 10 employees. The unemployment rate is defined as a percentage of the total labour force.

firms, unemployment fell alongside a relatively flat vacancy rate, a development which has persisted even through the pandemic. This is in stark contrast to the dramatic increase in vacancies recorded in the US following the COVID-19 outbreak, as depicted in Chart 19 by the green segment of the Beveridge curve.[14] When considering firms with over 10 employees, instead, the curve is steeper and has not changed relative to the pre-crisis period.

As one would probably expect, a shift out during the recovery could be considered evidence of improved efficiency, controlling for the cycle, arguably a result of the structural labour market reforms undertaken over the past decade. Similarly, while both charts indicate an increase in tightness (the ratio of vacancies to unemployment), the increase in the bottom panel is much stronger.

The improvement in the Greek labour market is a result of both an increase in the finding rate and a decrease in the separation rate (Chart 21). This is common for continental European countries, and unlike Nordic or Anglo-Saxon countries, where movements in the finding rate drive the majority of the cycle. In fact, the finding rate stalled somewhat in the last few quarters before the pandemic, but has risen substantially since.

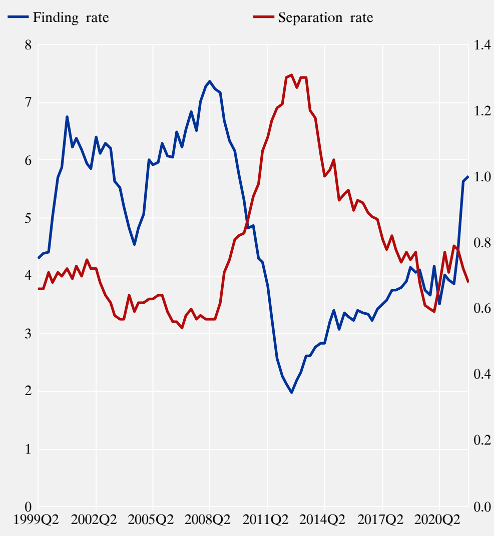
Putting these charts together, we have clear evidence of improvements in the labour market, though with unclear relative magnitudes regarding efficiency and tightness. Depending on the vacancy measure, there is either mildly increasing efficiency and rapidly increasing tightness, or vice versa. The large reduction in unemployment, together with the extensive set of labour market reforms during the crisis years, make both cases likely. Indeed, the increase in efficiency due to the reforms is the reason why, in the Greek Beveridge curve, we do not observe the banana-shaped recovery, common in other advanced economies.

It is not possible to analyse these implications further, in particular with regard to wages,

14 The pandemic seems to have dealt a strong blow to the efficiency of the US labour market, by shifting out the Beveridge curve greatly. It has been argued, however, that in the present context of the Great Resignation and the increased job-to-job transition rates, looking at only unemployment may be misleading about the level of tightness in the labour market. In particular, to the extent that a significant number of new jobs are taken by already employed individuals, then just comparing vacancies with unemployment will tend to underestimate the level of interested workers per vacancy, and hence overestimate both tightness and inefficiency.

Chart 21 Job finding and separation rates in Greece

(%)



Sources: LFS, Eurostat and Bank of Greece calculations.
Notes: Finding and separation rates are calculated using the procedure of Shimer, R. (2012), "Reassessing the Ins and Outs of Unemployment", *Review of Economic Dynamics*, 15(2), 127-148; and the refinement of Elsby, M., B. Hobijn, and A. Şahin (2013), "Unemployment Dynamics in the OECD", *Review of Economics and Statistics*, 95(2), 530-548.

without a model. Either case is consistent with a combination of productivity and efficiency shocks, as well as (to a lesser extent) bargaining shocks. Establishing which shocks dominate is beyond the scope of this article, whose intent is to lay out the different scenarios. In particular, in a standard search and matching framework, the difference depends on the relative size of shocks.[15] In both cases, the results are consistent with an increase in productivity (profitability), which would induce firms to increase vacancies and hence employment, as well as to offer higher wages, given the assumed higher productivity. Higher efficiency and moderately increasing tightness (i.e. an inward shift of the curve, as in the top panel of Chart 20) may additionally reflect higher bargaining power, which would explain why firms might avoid posting more vacancies per unemployed worker. Instead, higher tightness but mostly constant efficiency (i.e. a movement along the curve, as in the bottom panel of Chart 20) is consistent with a larger role for productivity; higher productivity raises tightness for given bargaining power and efficiency.[16]

Either of these two scenarios implies higher wages. Moreover, the larger the role for productivity, the more likely it is that further wage gains may occur (e.g. when bargaining power improves), without disrupting employment gains. However, an inward shift of the Beveridge curve without an increase in the vacancy rate is less empirically plausible, and so the second case, with a larger role for productivity gains, seems more likely. That said, establishing the relative statistical significance of each of the aforementioned shocks in driving recent developments in the Greek labour market is an empirical matter which remains to be addressed.

5.2 EFFICIENT UNEMPLOYMENT

The literature typically measures the unemployment gap by comparing actual unemployment with trend unemployment or NAIRU. A fundamental problem with both these measures is that, because they are latent, they are calculated using unobserved components models, which are known to be particularly problematic in end-points and hence real-time estimation. A second problem has to do with the interpretation of the measures; the trend measure may make little sense in an economy with as large shocks as the Greek one, while NAIRU can also be a poor measure of slack at a time of large supply shocks, such as the current episode.

A new alternative measure, proposed by Michaillat and Saez (2021),[17] is theoretically grounded and is designed to account for the fact that unemployment is itself wasteful, as willing workers remain idle, but the recruiting process is also wasteful, as hiring committees

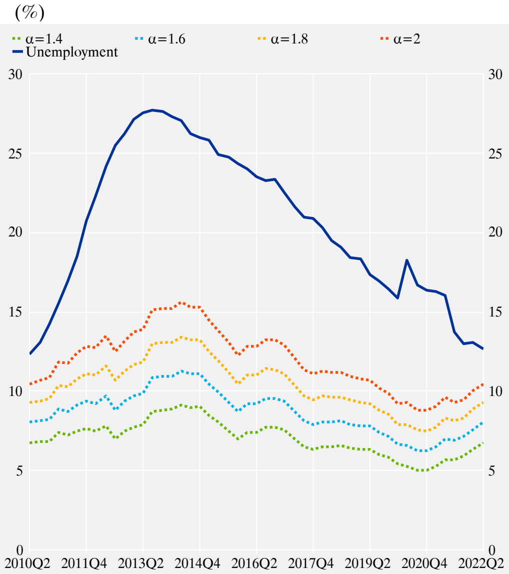
15 For a deeper discussion of the framework, see Consolo, A. and A. Dias da Silva (2019), "The euro area labour market through the lens of the Beveridge curve", ECB, *Economic Bulletin*, Issue 4.
16 The rise is higher with lower worker bargaining power, but this is an unlikely scenario at the current juncture.
17 See Michaillat, P. and E. Saez (2021), "Beveridgean unemployment gap", *Journal of Public Economics Plus.*

need to expend valuable resources in non-productive activities. This gives rise to the notion of "efficient unemployment", the rate of unemployment which minimises the sum of unemployment and vacancy creation, subject to the Beveridge curve, which recognises that it is not possible to reduce both unemployment and vacancies to zero at the same time. Frictions in the labour market imply that vacancies are needed to reduce unemployment, and that lower vacancies will raise unemployment.

Michaillat and Saez (2021) end up with a sufficient statistic formula composed of three parameters: the slope of the Beveridge curve, the cost of recruiting, and the value of non-employment. We estimate the slope of the Beveridge curve with Greek data, taking into account structural breaks around turning points in the cycle. The elasticity is estimated to be between 1.4 and 2, depending on the sample and definition used (excluding outliers).[18] This is substantially higher than the value of around 1 reported for the US, which is reasonable given the much lower levels of trend unemployment in the US.[19] Given model and estimation uncertainty, we consider levels of u^* for values of the elasticity α from 1.4 to 2. In our baseline estimates, we use the same value of non-labour ζ as Michaillat and Saez (2021) at 0.26 (especially given that the US values have a very large confidence interval), while we assume the cost of recruiting $\varkappa$ is at 2, double the US value.[20]

The estimates are shown in Chart 22. We plot, in dark blue, actual headline unemployment, together with efficient unemployment under four different levels of the Beveridge elasticity, from 1.4 to 2. As expected, the value of efficient unemployment is a key predictor of the Beveridge elasticity; moreover, the higher unemployment is, the larger the discrepancy of u^* across different measures. Focusing on the current juncture, we see that for all values of the Beveridge elasticity, u^* is comfortably below the current value of headline unemployment of 11.8% (September 2022); with an elasticity of 2, u^* is 10.1%, indicating that there

Chart 22 Efficient unemployment in Greece



Sources: LFS, Eurostat and Bank of Greece calculations.
Note: Efficient unemployment is estimated using the method of Michaillat, P. and E. Saez (2021), "Beveridgean unemployment gap", *Journal of Public Economics Plus*, 2 (2021).

still exists slack in the labour market. Note that slack in this context refers to underutilisation of resources below their efficient level and does not imply the existence of price pressures, as does its more common interpretation in a NAIRU/Phillips curve framework.

The 10% value is likely a conservative estimate. It assumes that u^* is essentially at the same level as in 2010, despite a very expansive set of reforms that took place during the crisis years. It is also based on conservative assumptions about the cost of recruiting and the value of

18 The procedure involves regressing log vacancies on log unemployment, for each segment of the Beveridge curve, to take into account the breaks in the relationship at turning points of the business cycle. There are several breaks whose identification is required. Michaillat and Saez (2021) use the Bai-Perron procedure, and that same approach is followed here as well. The estimation is conducted separately in each segment. See Michaillat, P. and E. Saez (2021), "Beveridgean unemployment gap", *Journal of Public Economics Plus.*

19 The specific features of the Greek labour market, where informal networks are likely more important than in the US or other EU countries, may mean that firms post fewer vacancies for given labour needs. However, the survey asks firms about positions they create and take steps to fill; it does not require that a formal vacancy is posted.

20 Sensitivity checks have been performed and are available upon request.

non-labour. Sensitivity checks show that less conservative values, especially for the cost of recruiting, give larger values of slack.[21] With the baseline calibration, a value of the Beveridge elasticity α of 1.8 gives u^* equal to 9%. Note that, while efficient unemployment remains well below headline unemployment, irrespective of the calibration used, there is clearly a rapid narrowing of the distance between actual and efficient unemployment in Chart 22. Not only has actual unemployment fallen in recent years, but efficient unemployment has also risen, as a result of higher vacancy creation. This suggests that, while still slack, the Greek labour market could tighten over the medium term, if current trends persist.

6 WAGES AND EMPLOYMENT FLOWS: INSIGHTS FROM THE ERGANI INFORMATION SYSTEM

This section focuses on the evolution of employment flows and wages across major sectors of activity, with the general aim of identifying common trends and indications of market tightness. Our analysis of employment developments is based on data for the period from January 2016 to December 2021 from the ERGANI information system, an administrative database covering the whole population of employees working under private law contracts in Greece.[22] The data used in this section are micro-aggregated data from the ERGANI monthly flows as well as the ERGANI annual accounts. The information available to us refers to monthly employment flows (i.e. hires, fires and voluntary exits/resignations) and their respective wage. We also use annual wages for the employment stock as obtained from the ERGANI annual accounts, which are extrapolated to a monthly frequency for comparability. In particular, we have the above information across the following worker, employer and job characteristics, respectively: (i) worker gender, age and occupation; (ii) region, main sector of establishment activity, firm size (in number of employees); (iii) type of job contract (open-ended or fixed-term) and type of employment (full-time, part-time or intermittent).[23]

The analysis is limited to full-time jobs, which ensures comparability of wages. For concreteness we also focus our analysis on the sectoral and skill dimension of the data by aggregating appropriately the relevant information.

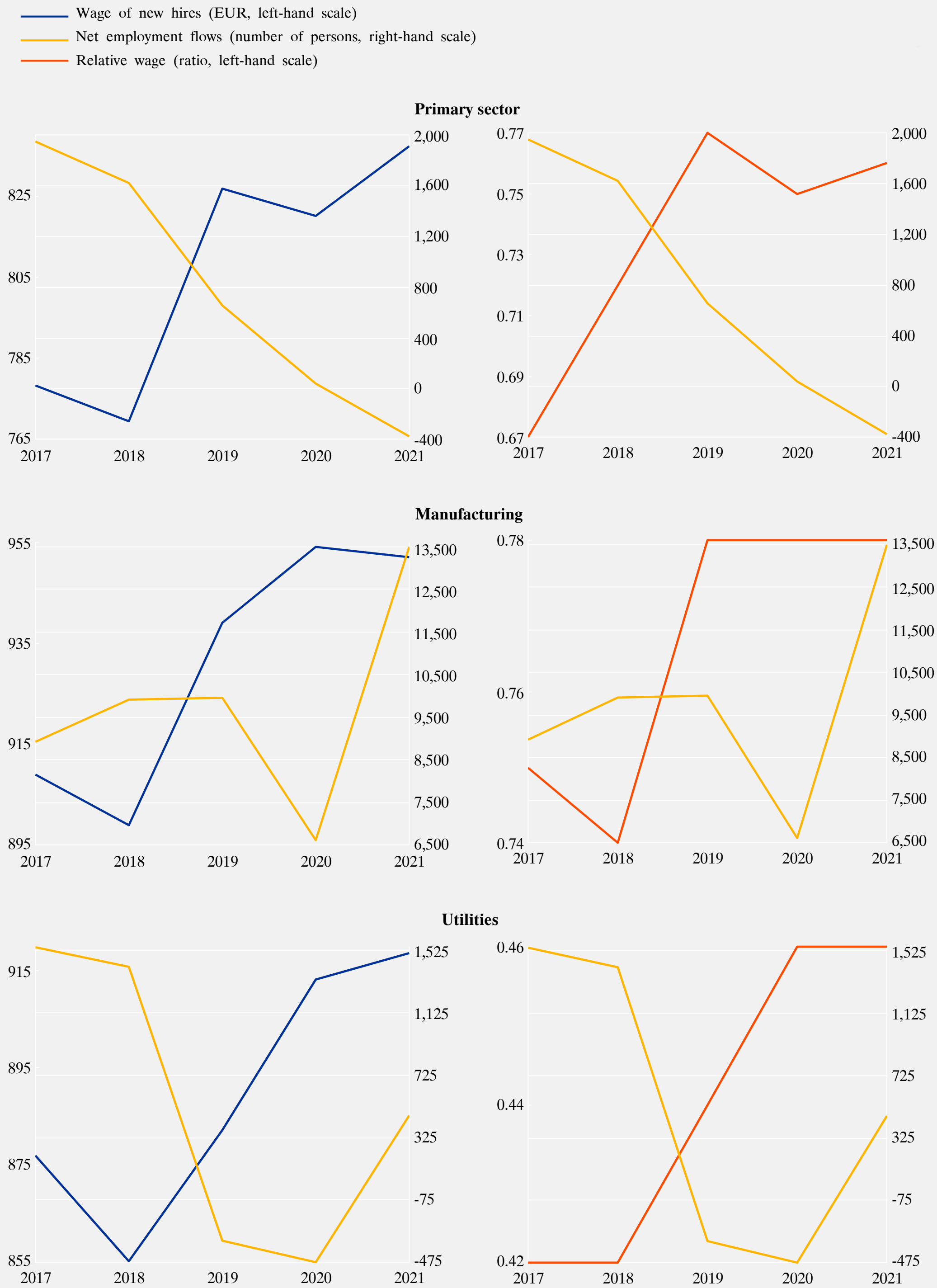
We will proceed by presenting net employment flows (hires-fires-voluntary exits) and the respective wage of the new hires in order to see whether any significant common trends emerge (see Chart 23). Moreover, to see how the wage of newcomers compares to the wage of those already employed, we also analyse the evolution of the wage of newcomers in relation to the wage of the relevant employment stock. Usually, the wages of the incumbent workers benefit from a tenure-related premium, which reflects the firm-specific human capital that has been acquired through the years. If the wage of newcomers comes closer to the wage of incumbent workers, i.e. their relative wage comes closer to one, there are indications of wage pressures as the newcomers get a premium in order to accept the job offer, which reduces the wage differential relative to incumbents.

Most major sectors exhibit positive net employment flows in the years following the COVID-19 outbreak, with the exception of Utilities and the Primary sector, the net flows of which are mostly in negative territory. The Manufacturing, Construction, Trade, Transportation & Storage (T&S in Chart 23) and Other Services sectors are characterised by significant net employment flows that are above those of the pre-COVID period.

Hotels & Restaurants also exhibits significant positive net employment flows following the

21 Available upon request.
22 This database includes information submitted by all private sector employers and serves as a detailed registry of the employment in the private sector. Employees working in public sector entities, whose contracts are governed by private sector labour laws are also registered in this database. The information collected is at the job-employment position level.
23 This information is available at the level of 89 2-digit NACE sectors of activity, 7 age categories, 46 occupation categories, 12 firm size categories, 13 NUTS-2 regions (for a description of the data dimension, see Kosma, T., P. Petroulas and E. Vourvachaki (2020) "What drives wage differentials in Greece: workplaces or workers?", Bank of Greece, *Economic Bulletin*, 52, pp. 69-72, December).

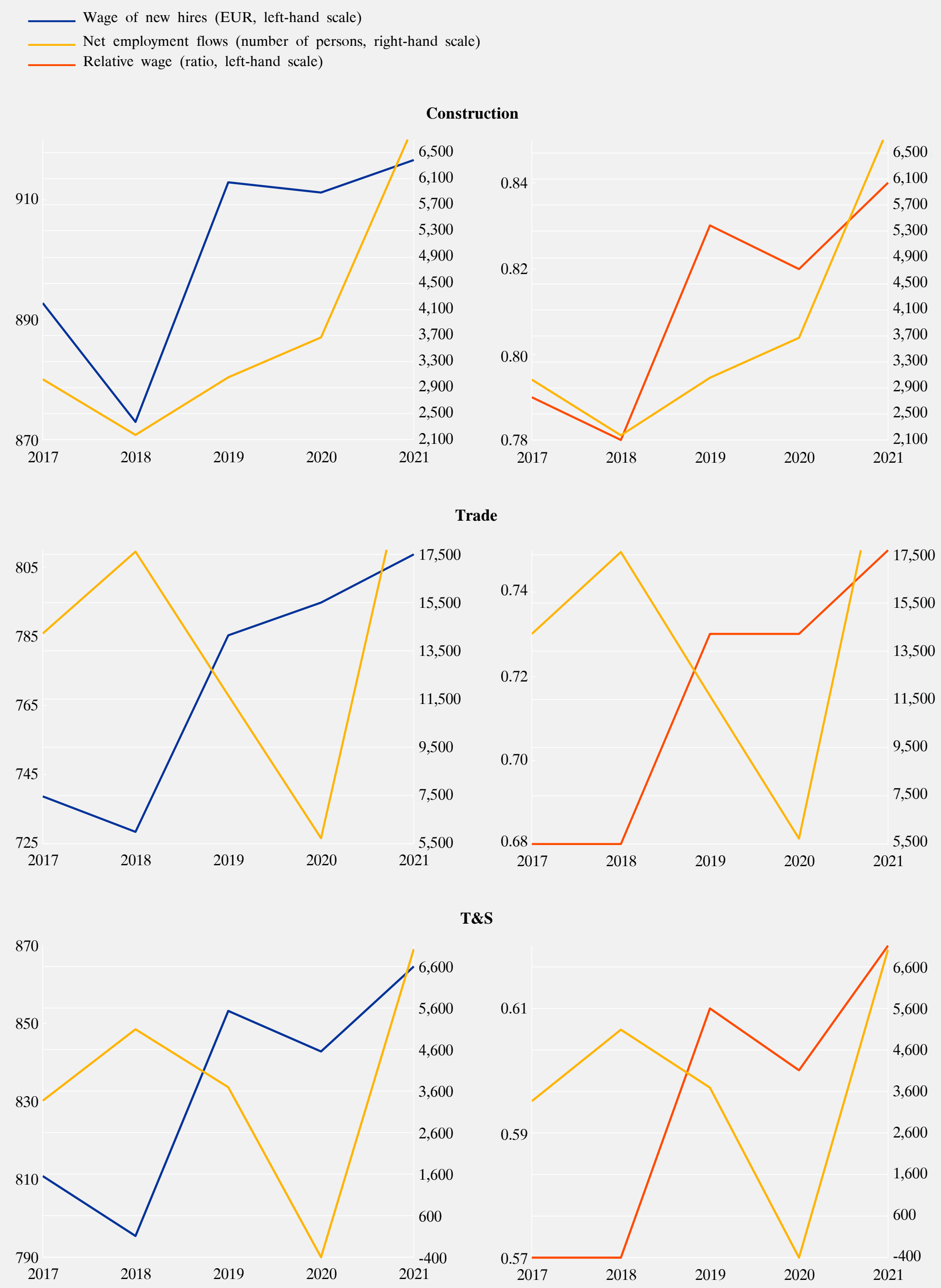
Chart 23 Net employment flows and wage developments for new hires in main sectors of activity



Source: ERGANI and Bank of Greece calculations.
Note: Net employment flows are total flows in the year (sum of monthly net flows) to address seasonality. The wages of newcomers are year averages based on monthly data. The relative wage is the ratio of the wage of newcomers to the respective wage of the employment stock obtained from the annual ERGANI accounts referring to November in each year.

Chart 23 Net employment flows and wage developments for new hires in main sectors of activity

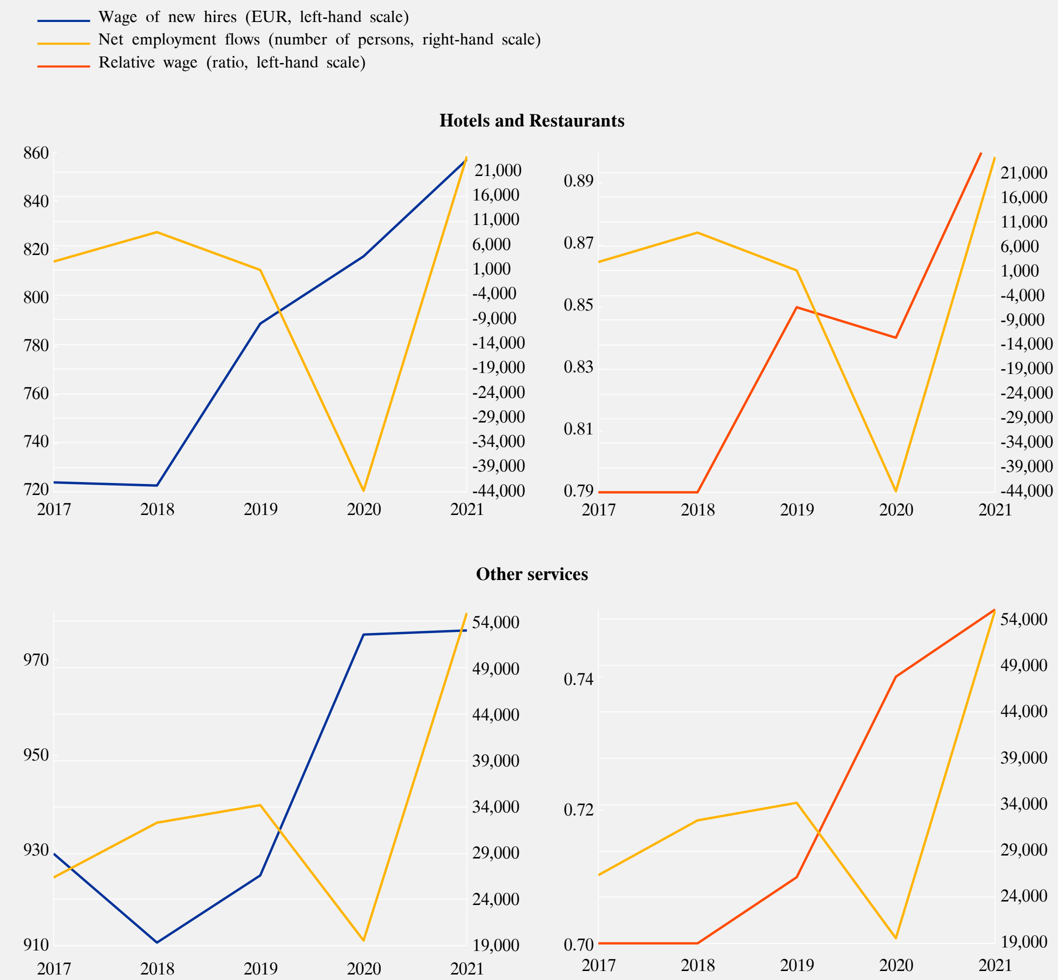
(continued)



Source: ERGANI and Bank of Greece calculations.
Note: Net employment flows are total flows in the year (sum of monthly net flows) to address seasonality. The wages of newcomers are year averages based on monthly data. The relative wage is the ratio of the wage of newcomers to the respective wage of the employment stock obtained from the annual ERGANI accounts referring to November in each year.

Chart 23 Net employment flows and wage developments for new hires in main sectors of activity

(continued)



Source: ERGANI and Bank of Greece calculations.
Note: Net employment flows are total flows in the year (sum of monthly net flows) to address seasonality. The wages of newcomers are year averages based on monthly data. The relative wage is the ratio of the wage of newcomers to the respective wage of the employment stock obtained from the annual ERGANI accounts referring to November in each year. Other services include NACE sectors 58 to 99.

remarkable decline in net flows after the adoption of the social distancing measures. Actually, Hotels & Restaurants is the only major sector with significant negative net employment flows in 2020, which do not seem to have been counterbalanced yet by the consecutive positive net employment flows in 2021. Specifically, while we observed declines of a magnitude of about 43,000 positions cumulatively in 2020, the corresponding increase in 2021 is about 24,000 positions. However, it is not feasible to infer from our data whether this was due to the social distancing measures remaining in 2021 (i.e. demand effects due to partial reopening of the sector) or due to labour supply effects. Even so, it seems that the "lost" flows of the hospitality sector have moved to the Other Services sector which overperformed in terms of new hires. Specifically, in 2021 new hires stood at around 35,000 positions above the corresponding 2020 level and about 20,000 positions above the 2019 level. We can also note that the Other Services sector has a somewhat higher average wage for new hires, i.e. around €980 compared to €850 in the Hotels & Restaurants sector, and significantly less seasonality in employment. In this respect, there are strong indications that during the COVID-19 period workers shifted jobs from the hospitality sector to Other Services for both a better pay and more "constant" employment.

In sum, whereas the post-COVID period of 2021 has been characterised by robust employment dynamics across most major sectors, the question is whether they have been followed by any significant wage increases. For most sectors, the wages of new hires and their relative wages compared to those of incumbent workers do not depict any significant upward trend.[24] Other Services, Hotels & Restaurants, and Construction are the three sectors with an upward trend in wages of new hires as well as in employment flows. The combination of the two could be indicative of some emerging market pressures. However, the upward trend in wages for Other Services is more modest and the wages of new hires are still well below those of incumbents (at 75%). By contrast, the upward trend in relative wages of new hires is more pronounced, reaching 85% for Construction and almost 90% for Hotels & Restaurants on average in 2021.[25] Thus, in what follows we delve deeper into the employment and wage dynamics of these two sectors.

We decompose employment flows in the Construction and Hotels & Restaurants sectors by four skill categories: high-skilled white collar, low-skilled white collar, high-skilled blue collar and low-skilled blue collar, to observe whether the above developments are driven by any particular skill category.[26]

In the Construction sector, in terms of employment, all segments, both blue and white collar workers as well as high- and low-skilled workers have seen a strong increase in net employments flows in the post-COVID period. Moreover, for blue collar workers in particular there was no strong decline of employment flows during the pandemic. For new hires, blue collar workers (both high- and low-skilled) have seen a significant increase in wages. Wage pressures in the blue collar segment of Construction seem to be present as well. In particular, the wages of new blue collar hires are fast approaching those of incumbents being about 90%. By contrast, for white collar workers, new hires do not exhibit an upward trend in wages if they are high-skilled, or are far below the wages of incumbents if they are low-skilled. In this respect, the data show that wage and employment pressures in the Construction sector are mainly driven by the blue collars' market segment.

For Hotels & Restaurants, the main contributor to the developments in this sector is the low-skilled white collar segment. In particular, we can note the sheer size of outflows during the pandemic, which reached a total of 34,000 in 2020, while the subsequent increase barely reached a total of 19,000 positions in 2021. Moreover, the relative wage of new hires versus incumbents has reached high levels of above 95% in 2021 (up from about 84% in 2017), on average. For the low-skilled blue collar segment, similar developments are observed, albeit at significant lower magnitudes. For both these categories a non-negligible tightness in their respective sectoral labour market is indicated by the data.

On balance, the ERGANI data indicate that there is no general tightness in the labour market. That is, the wages of new hires are not increasing significantly, in tandem with strong employment developments. However, there are some specific sectors and worker types for which the respective segments of the labour market indicate some tightness.

In particular, for Construction, we can note that it is a sector which has seen a significant

24 One could note, though, an upward shift in wages in the trade sector at the beginning of 2019, which can be related to the minimum wage increase in February 2019.
25 In Hotels & Restaurants we observe relative wages which are close to 90%, indicating a high premium for the new hires. However, a specificity of this particular sector should be noted at this point. This is a sector with high seasonality where hires and layoffs may refer to the same employee. Therefore, the same employee is hired at the beginning of the tourist season with a wage similar to that of the previous year and is laid off at the end of the tourist season.
26 Charts are not presented for space considerations but are available upon request.

decline in the level of activity during the last decade and where a significant share of the labour pool has disappeared. In this respect, the Construction sector is expected to continue having a tight labour market in the foreseeable future. For Hotels & Restaurants, there are indications that the outflow of labour during the pandemic has to a large extent been absorbed by the Other Services sector. If this is the case, we can note that the wage for a new hire in Other Services is approximately 15-20% higher (depending on the skill category) than in Hotels & Restaurants. Moreover, Other Services does not have the same seasonality in employment (and hence income) as Hotels & Restaurants. Thus, from an employee's perspective, if they have switched sectors, they may have experienced both a higher and more steady income. In this respect, it will be difficult to attract them back to the Hotels & Restaurants sector.

7 A SNAPSHOT OF SKILLS AND SKILLS MISMATCH

7.1 SURVEY EVIDENCE

Turning to more qualitative evidence of labour market mismatch, a common finding reported in business surveys is that of limited availability of skilled labour. Indeed, on the labour demand side, skill shortages have been consistently high in Greece. According to the Survey on the Access to Finance of Enterprises (SAFE),[27] the second most pressing problem for Greek SMEs in the second half of 2021, following the cost of production or labour, is the availability of skilled staff and/or experienced managers (reported by approximately 18%). Data from the EIB Investment Survey 2021[28] show that the limited availability of skills has increasingly become a concern for firms: 73% of Greek firms reported the limited availability of staff with the right skills as an impediment to long-term investment. Moreover, according to the latest Manpower Talent Shortage Survey[29] (which covers more than 40 countries globally), in Greece talent shortages reached a 10-year high in 2022, as 78% of Greek firms report talent shortages,[30] i.e. they cannot find employees with the blend of technical skills and human strengths they need. Especially in Attica, 61% of employers state that they face relative difficulty in searching for talent, 18% a lot of difficulty and 19% none. As for response variation by company size, 23% of very small businesses, 17% of small businesses, 16% of medium-sized businesses and 14% of large businesses have a lot of difficulty filling positions. Accordingly, 54% of very small businesses, 63% of small businesses, 58% of medium-sized businesses and 65% of large businesses experience relative difficulty. Greater difficulty is found in the manufacturing sector, with 30% of employers reporting that they are having a very difficult time filling positions due to a lack of talent and 63% reporting relative difficulty. Most employers (23%) report that it is more difficult to find talent in Human Resources (with small businesses facing a more acute problem), followed by IT/Data and manufacturing.

However, the problem existed even before the pandemic. In fact, according to the European Company Survey 2019,[31] 66% of Greek firms indicated that they have difficulty in finding employees with the right skills (EU average: 76%). When asked what percentage of their employees have skills that are about right to do the job, only 33% reported a percentage of 80% or more (one of the lowest percentages).

To date, most EU Member States, including Greece, have responded to the challenges posed by demand for higher skills by seeking to increase skills supply, mostly through raising educational attainment. Notably, according to the latest OECD education data, in Greece,

27 https://www.ecb.europa.eu/stats/ecb_surveys/safe/html/index.en.html.
28 https://www.eib.org/en/publications/econ-eibis-2021-eu.
29 https://go.manpowergroup.com/hubfs/Talent%20Shortage%20-2022 /MPG_2022_TS_Infographic-Greece.pdf.
30 60% of employers state that they face relative difficulty in filling positions due to a lack of talent, 18% a lot of difficulty and 20% none.
31 https://www.eurofound.europa.eu/surveys/2019/european-company-survey-2019.

in 2021, 44% of 25-64 year-olds had attained tertiary education, against 33% in 2011.[32] 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.[33] However, there are concerns that the Greek 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 their future employers are likely to seek.

In the Global Talent Competitiveness Index 2022, Greece ranked 40th out of a sample of 133 countries. The country's main strength relates to retaining talent (mainly thanks to the lifestyle offered) and the quality of the talent (mainly thanks to the availability of high-level skills and professionals). The greatest scope for improvement, meanwhile, is in vocational and technical skills, and in attracting talent.[34] Greece had one of the lowest overall scores in the European Skills Index survey for 2022, only marginally improving its performance relative to 2020 (achieving a score of 23 from 20), pointing to a relatively weak skills system in Greece on multiple fronts.[35] Greece ranked 41st out of 141 countries in the skills sub-pillar of the Global Competitiveness Index 4.0 published by the World Economic Forum in 2019 (up from 36th in 2017).[36]

Because of structural digitalisation trends and the recent rapid change in labour markets following the COVID-19 outbreak, digital skill needs have grown. CEDEFOP's second European Skills and Jobs Survey (ESJS2) shows that the health crisis affected the employment of one in three EU+ workers (33%), with younger and lower-educated workers most negatively affected.[37,38] In Greece, 48% of adult employees had to learn to use new digital technologies to do their main job in 2020-21. Moreover, most EU+ adult workers use a computer device (a desktop computer, laptop or notebook, tablet or smartphone) as part of their work, and more than eight in ten EU+ jobs (87%) require at least basic digital skills. The need to learn to work with new computer technologies challenges individuals to update, upgrade or learn new digital skills; in the short to medium term this can cause imbalances between digital skills demand and supply. Greece ranks 25th among EU-27 countries as regards the Digital Economy and Society Index for 2022. As regards human capital, in 2021, 52% of the Greek population was equipped with basic or above basic digital skills (very close to the EU average of 54%). However, the share of ICT specialists in total employment barely reached 2.8%, i.e. the second lowest among EU-27 countries (EU-27: 4.5%), despite some progress in the past three years.

At the same time, according to data from the OECD Survey of Adult Skills (PIAAC), 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. Moreover, only 2.5% of adults in Greece attain the highest proficiency level in problem-solving in technology-rich environments. This is the fourth lowest percentage among all participating countries and significantly lower than the OECD average of 5.4%.

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. How-

32 https://www.oecd-ilibrary.org/docserver/3197152b-en.pdf?expires=1667392434&id=id&accname=ocid177073a&checksum=8B310EE22CEC9AE099EB8DD5FDC15B73.
33 CEDEFOP (2020), Skills forecast 2020: Greece, CEDEFOP skills forecast.
34 https://www.insead.edu/sites/default/files/assets/dept/fr/gtci/GTCI-2022-report.pdf.
35 A score of 23 suggests that the country has reached 23% of the ideal performance and that there is still 77% room for improvement. A score of 100 corresponds to achieving the "frontier": https://www.cedefop.europa.eu/en/tools/european-skills-index.
36 https://www3.weforum.org/docs/WEF_TheGlobalCompetitiveness Report2019.pdf.
37 EU Member States plus Norway and Iceland.
38 https://www.cedefop.europa.eu/files/9173_en.pdf.

ever, data from PIACC also 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 economies and much higher than the OECD average of 10.8%. 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. Most graduates in the areas of Arts and Humanities (80%) and ICT (more than 70%) are employed in jobs that do not match their sector of specialisation.

To add to the above evidence, Eurostat's experimental indicators on skills mismatches provide information on vertical skills mismatches (overqualification rates) and horizontal skills mismatches (job mismatch by field of education).[39] For Greece, there has been a 10.3% increase between 2008 and 2020 in the overqualification rate (i.e. % of people aged 20-64 with tertiary education and working in ISCO 4-9). At the same time, the horizontal skills mismatch rate was 26.4% for the age group 15-34 and 30% for the age group 25-34 in 2020.

An efficient allocation of workers across tasks is particularly important when the aggregate skills supply is relatively limited, as is the case with Greece. Persistent skill 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. 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. To steer technological development, vocational education and training (VET) should enable those exposed to technological innovation to reduce their digital skill gaps. The implementation of these policies will help ensure that technology adoption has a positive impact on both productivity and workers.

7.2 AN EMPIRICAL EXPLORATION[40]

In line with theoretical predictions, mismatch has been shown to be significantly negatively related to labour productivity.[41] Chart 24 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. Moreover, 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.

Given the above evidence of high mismatch in professional occupations in Greece, it is interesting to examine the importance of overskill mismatch in professional occupations relative to others combining PIACC and Orbis data.[42]

39 More information on these experimental indicators is available at https://ec.europa.eu/eurostat/web/experimental-statistics/skills

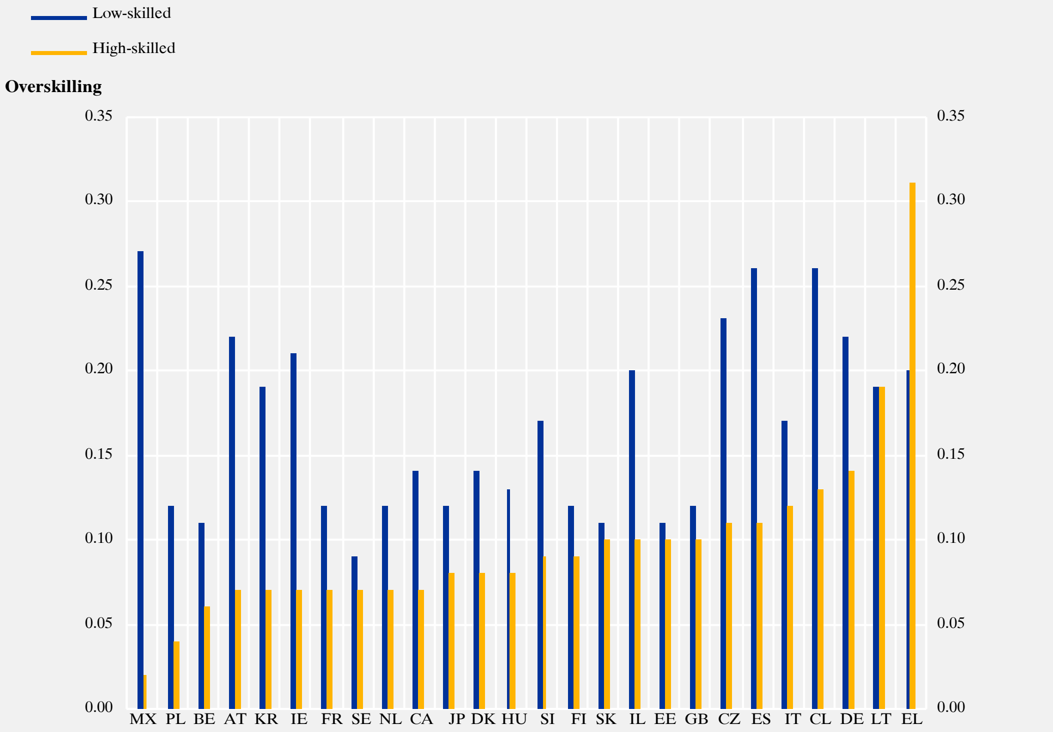
40 For a more in depth analysis, see Anyfantaki, S., Y. Caloghirou, K. Dellis, A. Karadimitropoulou and F. Petroulakis (2022), "Skills, management practices and technology adoption in Greek manufacturing firms", Bank of Greece, *Economic Bulletin*, 55.

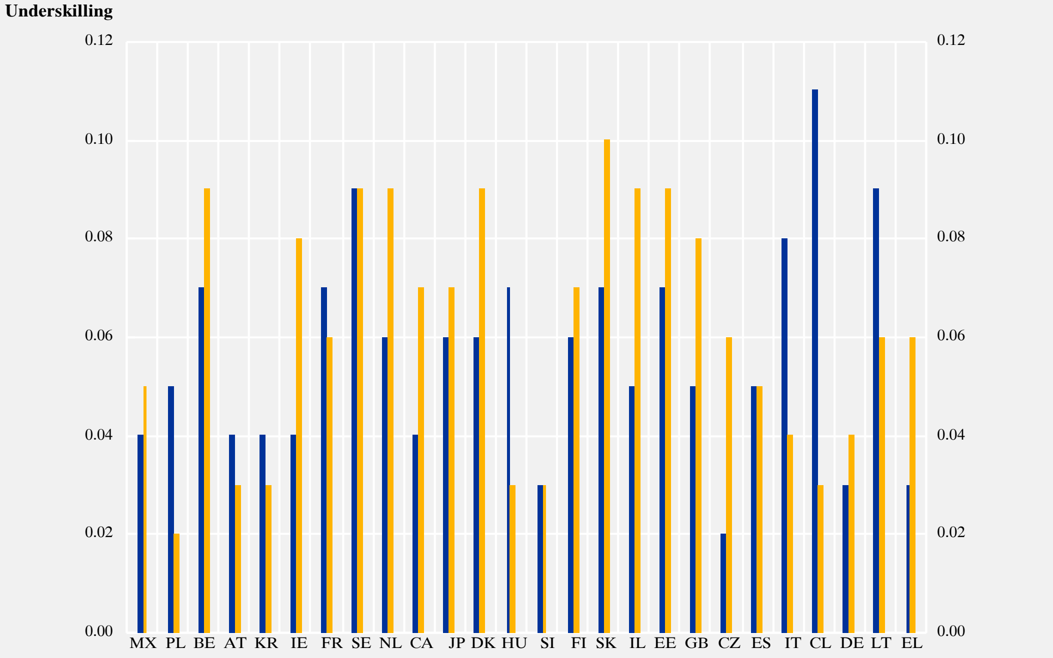
41 See, among others, Decker, R.A., J. Haltiwanger, R.S. Jarmin and J. Miranda (2017), "Declining dynamism, allocative efficiency, and the productivity slowdown", *American Economic Review*, 107(5), 322-326; Hsieh, C.T. and P.J. Klenow (2009), "Misallocation and manufacturing TFP in China and India", *The Quarterly Journal of Economics*, 124(4), 1403-1448.

42 Data for productivity from Orbis include 17 countries (Austria, Belgium, Germany, Denmark, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Italy, Japan, Korea, Latvia, Sweden and Slovenia). All measures are averaged for each sector across 2009 and 2013 to improve reliability. Sectors covered are: 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 technologies; professional, scientific and technical activities; administrative and support service activities.

Chart 24 Skills mismatch for high- and low-skilled occupations

(share of employment)





Source: OECD, Survey of Adult Skills (PIACC).
Note: 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-, medium- and low-skilled occupations are ISCO occupational groups 1 to 3, 4 to 8 and 9, respectively. Literacy proficiency is the proxy for skills.

Adalet McGowan and Andrews (2015)[43] split aggregate productivity in each sector into a within-firm component and an allocative efficiency component. Allocative efficiency requires that resources flow to their more productive uses. As such, if more productive firms are larger, then the allocative efficiency term is positive. The effect of mismatch on productivity can be estimated through linear regression models, separately for the three productivity measures (aggregate sectoral, allocative efficiency and average firm) on under- and overskill mismatch indicators at the sectoral level. In fact, when the aggregate sectoral productivity is the dependent variable, 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, holding constant the share of underskilled workers, reduces weighted sectoral productivity by almost 10%.[44] Overall, the results corroborate the findings of Adalet McGowan and Andrews (2015): overskilling has a negative effect on productivity. Although regression analysis is only meant to be indicative, given the small cell sizes especially for the professional occupations, the upshot is that overskill mismatch plays an important role for productivity, and overskilling in professional occupations, where Greece scores especially poorly, is a major drag.

Overall, the analysis suggests 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 for both higher education as well as vocational education and training (VET). More specifically, concrete strategic initiatives should be carefully designed and implemented. These could include: (a) establishing and promoting university-industry cooperation schemes; (b) maintaining a balance between formal education, in-firm training and lifelong learning; (c) maintaining a balance between the formal and tacit curricula in Greek universities; and (d) upgrading secondary and upper-secondary technical-vocational education and training.

8 CONCLUSIONS

Euro area labour markets are much tighter than they were before the pandemic, with unemployment at a record low and vacancies rising across sectors. Conversely, in Greece, the labour market is still not tight overall. Unemployment is nearly double the euro area average and, although the job vacancy rate increased after the pandemic, it remains relatively low. However, there is heterogeneity at the sectoral level, with construction and trade, transport and accommodation presenting high job vacancy rates, and the tourism subsector in particular showing the greatest tightness by this measure. Similarly, while wage growth data do not show signs of generalised tightness, the Construction, Hotels & Restaurants and Other Services sectors exhibit an upward trend in the wages of new hires and in employment flows, which may reflect emerging labour market pressures.

Furthermore, it is notable that, while the unemployment rate in Greece remains high, it declined rapidly in recent years, reflecting government support measures during the pandemic, the implementation of important labour market reforms in the previous decade and robust real GDP growth. This sharp decline, in combination with the high share of long-term unemployment and the rather elevated estimates of efficient unemployment presented in this article, suggests that labour market slack may in fact be less than indicated by the baseline measure. Given recent strong employment growth and the prospect of a significant need for additional labour over the coming years

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

44 See Anyfantaki et al. (2022), op. cit., for a description of the methodology and detailed results.

due to the implementation of the NextGenerationEU plan, labour market tightness could increase significantly over the coming years. This concern is further compounded by extensive survey evidence of skills mismatches in the Greek labour market, which are known to adversely affect allocative efficiency and, thus, productivity.

It follows that, from a policy perspective, it is particularly important to pursue labour market policies aimed at increasing participation rates and upskilling or reskilling the labour force, including in particular the long-term unemployed. This need is all the more pressing in light of the adverse demographic trends and the recent exodus of young highly skilled workers following the sovereign debt crisis. Such active labour market policies would support employment, increase skills and enhance the experience of workers, especially the more vulnerable ones, thereby increasing attachment to the labour market and eventually resulting in higher employment and participation rates. As regards skills mismatch in particular, redesigning training programmes and educational curricula to be more closely linked to the needs of the labour market, as well as strengthening the digital literacy of workers would help reduce the mismatch between the job skills demanded by firms and those on offer, thus boosting productivity and potential output. In this regard, the measures included in Greece's National Recovery and Resilience Plan to foster labour market activation and upskilling through redesigning and strengthening active labour market policies are well-timed and crucially important.

ENERGY CONSUMPTION BY ENERGY TYPE AND EXPORTS OF GOODS IN GREECE: A COMPARATIVE ANALYSIS IN RELATION TO THE EURO AREA

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ABSTRACT

The rapid expansion of non-oil goods exports in Greece during the last decade contributed to raising net exports, despite the severe economic crisis the country was undergoing. Nevertheless, the EU's overall energy consumption exhibited a downward trend that was even stronger in Greece. This study examines the dynamic relationship between exports of non-energy goods and final consumption of energy in Greece and the euro area (EA) over the last two decades, considering five separate energy types. Single equation and panel estimations are employed, making it possible to compare the results of the two approaches. It is shown that exports of goods in Greece are dependent on final consumption of oil, electricity and renewable energy (RE), while the final consumption of natural gas, oil and electricity has an effect on goods exports in the EA. The largest effect on exports of goods in Greece comes from the consumption of electricity, part of which has been produced from RE in recent years. Greece's goods exports are found to have a higher dependence on RE consumption than the EA's, which is related to the recent higher growth of RE consumption. Statistically significant causal relationships are found between goods exports and the traditional energy types (i.e. oil and natural gas) both in Greece and the EA. The prospects for accelerating the energy transition are not as favourable, following the emergence of the energy crisis. This negative outlook may have consequences on Greece's improved openness and on the rising trajectory of goods exports.

Keywords: energy consumption; exports of goods; vector error correction model; panel estimation

JEL classification: F10; C01; C51

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ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΕΙΔΟΣ ΕΝΕΡΓΕΙΑΣ ΚΑΙ ΕΞΑΓΩΓΕΣ ΑΓΑΘΩΝ ΣΤΗΝ ΕΛΛΑΔΑ: ΣΥΓΚΡΙΤΙΚΗ ΑΝΑΛΥΣΗ ΣΕ ΣΧΕΣΗ ΜΕ ΤΗ ΖΩΝΗ ΤΟΥ ΕΥΡΩ

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ΠΕΡΙΛΗΨΗ

Η σημαντική αύξηση των εξαγωγών μη πετρελαϊκών αγαθών στην Ελλάδα την τελευταία δεκαετία συνέβαλε στην αύξηση των καθαρών εξαγωγών, παρά τη σοβαρή οικονομική κρίση που αντιμετώπιζε η χώρα. Ωστόσο, η συνολική κατανάλωση ενέργειας στην Ευρωπαϊκή Ένωση παρουσίασε πτωτική τάση, που ήταν ακόμη εντονότερη στην Ελλάδα. Η παρούσα μελέτη εξετάζει τη δυναμική σχέση μεταξύ των εξαγωγών μη ενεργειακών αγαθών και της τελικής κατανάλωσης ενέργειας για την Ελλάδα και τη ζώνη του ευρώ κατά την περίοδο των δύο τελευταίων δεκαετιών, λαμβάνοντας υπόψη πέντε διαφορετικούς τύπους ενέργειας. Χρησιμοποιούνται δύο εμπειρικές προσεγγίσεις, η απλή εξίσωση και η εκτίμηση με πάνελ, καθιστώντας δυνατή τη σύγκριση των αποτελεσμάτων. Διαπιστώνεται ότι οι εξαγωγές αγαθών στην Ελλάδα εξαρτώνται από την τελική κατανάλωση πετρελαίου, ηλεκτρικής ενέργειας και ανανεώσιμων πηγών ενέργειας (ΑΠΕ), ενώ η τελική κατανάλωση φυσικού αερίου, πετρελαίου και ηλεκτρικής ενέργειας έχουν σημαντική επίδραση στις εξαγωγές αγαθών στη ζώνη του ευρώ. Τον μεγαλύτερο αντίκτυπο στις εξαγωγές αγαθών στην Ελλάδα έχει η κατανάλωση ηλεκτρικής ενέργειας, μέρος της οποίας τα τελευταία χρόνια παράγεται από ΑΠΕ. Επίσης, διαπιστώθηκε ότι οι εξαγωγές αγαθών της Ελλάδος έχουν μεγαλύτερη εξάρτηση από την κατανάλωση ΑΠΕ σε σχέση με εκείνες της ζώνης του ευρώ, γεγονός που σχετίζεται με τους πρόσφατους υψηλότερους ρυθμούς αύξησης της κατανάλωσης ΑΠΕ. Βρέθηκαν σημαντικές αιτιώδεις σχέσεις μεταξύ των εξαγωγών αγαθών και των παραδοσιακών τύπων ενέργειας (δηλαδή πετρέλαιο και φυσικό αέριο) τόσο στην Ελλάδα όσο και στη ζώνη του ευρώ. Ωστόσο, οι προοπτικές για επιτάχυνση της ενεργειακής μετάβασης είναι λιγότερο ευνοϊκές με την εμφάνιση της ενεργειακής κρίσης. Επιπρόσθετα, αυτή η εξέλιξη είναι πιθανόν να επηρεάσει αρνητικά τη βελτίωση της εξωστρέφειας της Ελλάδος που παρατηρείται τα τελευταία χρόνια και την ανοδική πορεία των εξαγωγών αγαθών.

ENERGY CONSUMPTION BY ENERGY TYPE AND EXPORTS OF GOODS IN GREECE: A COMPARATIVE ANALYSIS IN RELATION TO THE EURO AREA*

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1 INTRODUCTION

During the last decade, net exports in Greece were on the rise, contributing to economic growth, despite the severe economic crisis the country was undergoing. This development was partly driven by the notable increase in goods exports, excluding oil, which had an average annual growth rate in real terms of approximately 7% during 2015-19 (higher than that of the euro area average, which was less than 2%). During the same period, a downward trend was identified in the EU's overall energy consumption, with a decrease of more than 10% between 2005 and 2015 (see, for example, European Environment Agency 2021a), which has been attributed to the global crises, i.e. the 2007-08 financial crisis and the 2020 COVID-19 pandemic. In addition, it has been found that the above decrease is related to increases in energy efficiency (Altdorfer 2017).[1] The downward trend in energy consumption was stronger in Greece,[2] where total final energy consumption decreased by 27%.[3] Thus, attention should be drawn to the impact of this decline on the growth of goods exports in Greece, which up to now has had a stimulating effect on the country's economy, since energy consumption is central to the production of goods.

This study examines the dynamic relationship between exports of non-energy goods and final consumption of energy in Greece and the euro area (EA) over the period of the last two decades, considering five separate energy types. It is shown that exports of goods in Greece are dependent on final consumption of oil, electricity and renewable energy (RE), while final consumption of natural gas, oil and electricity have an effect on goods exports in the EA. A larger effect on exports of goods in Greece comes from the consumption of electricity, part of which has been produced from RE in recent years. Significant causal relationships are found between goods exports and the traditional energy types (i.e. oil and natural gas) both in Greece and the EA. Another finding that refers to Greece concerns the shift towards clean energy, as the final consumption of RE is increasing, while the consumption of fossil fuels and oil is declining, which affects export growth. However, Russia's invasion of Ukraine and the emerging shock in energy markets related to Europe's dependence on traditional energy types have put strains on supplies, leading to high prices. This development, along with the resulting recession, inflation and economic uncertainty, increases the possibility of a setback in the shift towards clean and cheap energy, causing problems in all sectors of the economy, including exports of goods, which are highly dependent on the consumption of energy.[4]

The remainder of this paper is structured as follows. The next section identifies historical trends in final energy consumption from the 1990s to 2020 in Greece and the EA. Section 3 reviews the existing literature on the exports-energy relationship. The following section describes the data and the methodology and defines the empirical specification. Section 5 presents the estimation results and provides a discussion. Finally, Section 6 offers some conclusions and policy recommendations.

2 STYLISED FACTS

2.1 ENERGY CONSUMPTION PATTERNS

Greece's energy endowment comprises fossil fuels and hydroelectric energy. During the last

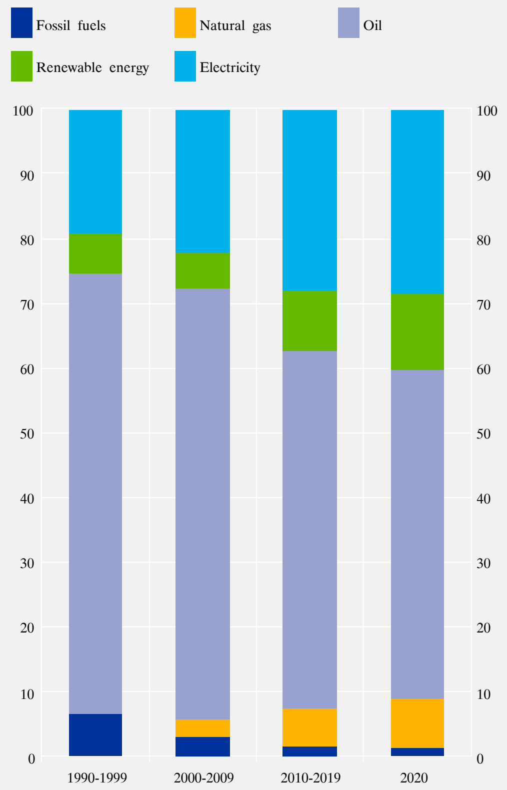
* The views expressed in this article are of the author and do not necessarily reflect those of the Bank of Greece. The author is responsible for any errors or omissions.
1 In 2020, energy consumption in the EU reached the lowest levels recorded since 1990, which is largely explained by the effects of the COVID-19 pandemic, and showed a recovery in 2021 (European Environment Agency 2021b).
2 Three times higher than that of the euro area (EA) average, which decreased by 9% (own calculations based on Eurostat data).
3 Greece surpassed its target for the first Kyoto Protocol commitment period of limiting the increase of greenhouse gas emissions, achieving a 17% rise over 2008-12 from 1990 levels (OECD 2020).
4 See Yergin (2022).

decade, the country began to exploit the plentiful resources of renewable energy it possesses, such as wind and solar energy. This was the result of a reform programme in the energy market launched in 2010. Greece's government has set climate change mitigation targets in line with EU targets and legislation, which have resulted in changing the energy mix.[5] The initial steps in reforming the Greek energy market focused on lignite. The government has set a goal to decommission all its lignite-based electricity by 2028. Following the outbreak of the COVID-19 pandemic, the EU required 37% of the financial support to Member States to be climate-related. As with other Member States, Greece's National Energy and Climate Plan (NECP) outlines the overall decarbonisation process, an important driver of which was the RE Special Account. This account ensured financial support providing incentives for producers to generate RE (Ioannidis 2022).

In the following we show the changes in the energy mix based on our dataset. Final consumption of fossil fuels (mainly in the form of lignite) has dropped by 25% since 2015 (same as the average EA decrease)[6] and now accounts for a small share in total consumption (about 1% in 2020, see Charts 1 and 2). Natural gas entered the Greek market in the early 2000s, its final consumption increased, but in 2020 it still covered a low proportion of total final energy consumption (8%, see Chart 1). Oil has the highest share in total final consumption in Greece as well as in the EA. It should be noted that the share of oil in total consumption in Greece was around 50%, significantly higher than the EA average (36%, see Chart 2). Nevertheless, oil consumption has decreased by 15% in the last five years due to EU legislation (-12% decrease in the EA), the COVID-19 crisis and price increases. Electricity is second in importance in Greece and in the EA regarding its share in final consumption.[7] The final consumption of electricity grew by 10% between 2013 and 2017 in Greece (1% in the EA) and its share in total final consumption in 2020 was 28%, above the respective EA average (24%). Moreover, as mentioned above, favourable

Chart 1 Shares of five energy types in total final energy consumption: Greece

(thousand tons of oil equivalent)



Source: Eurostat.

weather conditions in Greece allowed increases in renewable energy (RE) production. Solar and wind power generation capacity has grown significantly. Specifically, the share of RE in gross final energy consumption rose from 6.9% to 15.5% in 2017 (European Environment Agency Report 2021a and 2021b) and its share in gross final electricity consumption was projected to increase by 14% between 2018 and 2020 (OECD

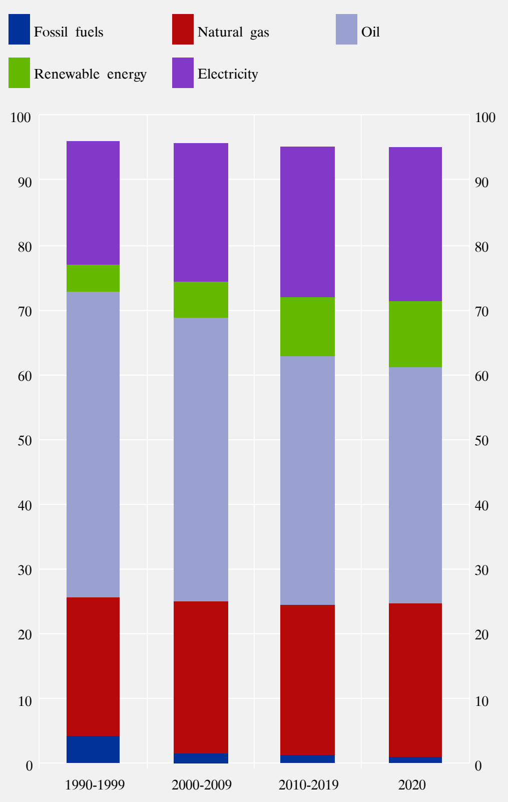
5 The steps taken by the Greek government that have led to a change in the energy mix are also described in OECD (2020) and include the ratification of the Kyoto Protocol in 2002 and the Paris Agreement in 2016. A Second National Climate Change Programme was adopted in 2002 regarding 2000-10 (amended in 2007) to achieve the target of Kyoto's first commitment period (2008-12).

6 The future course of the use of this type of energy is dictated by the 2020 Green Deal legislation of the European Commission, which introduced a commitment to reduce net greenhouse gas emissions by at least 55% by 2030. However, as mentioned above, the outbreak of the energy crisis in 2022 may undermine efforts in this direction.

7 In the EA, natural gas held a share (23%) in total energy consumption similar to electricity during 2015-20.

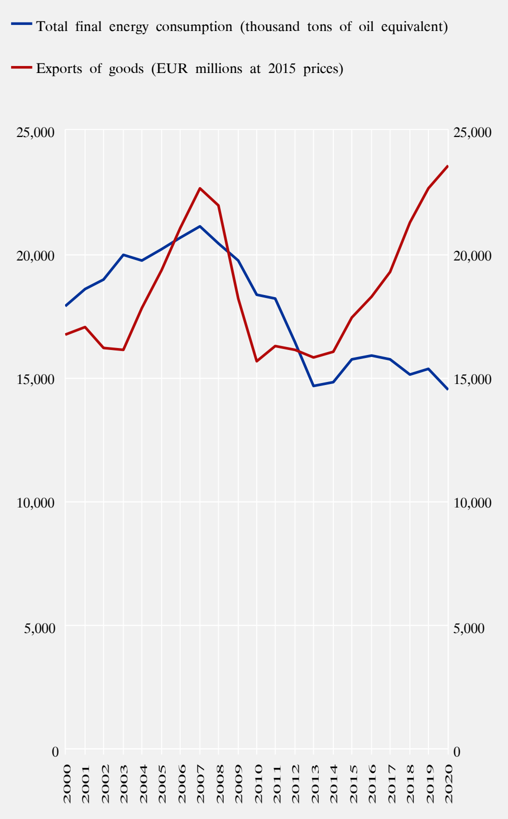
Chart 2 Shares of five energy types in total final energy consumption: euro area

(thousand tons of oil equivalent)



Source: Eurostat.

Chart 3 Energy consumption and exports of goods in Greece



Sources: Eurostat and own calculations.

2020). According to our Eurostat dataset, the final consumption of RE increased by 15% during the last five years (and by a total of 36% over the last decade). As a result, in 2020 the share of RE in total energy consumption was close to 12% (above the respective EA share, which was 11%). Finally, total final energy consumption has been decreasing over the last ten years in Greece, at an average annual rate close to -2.3% and a total decrease of -16% up to 2019, which exceed the corresponding EA rates (annual rate of -0.5%, total decrease close to -6%).[8]

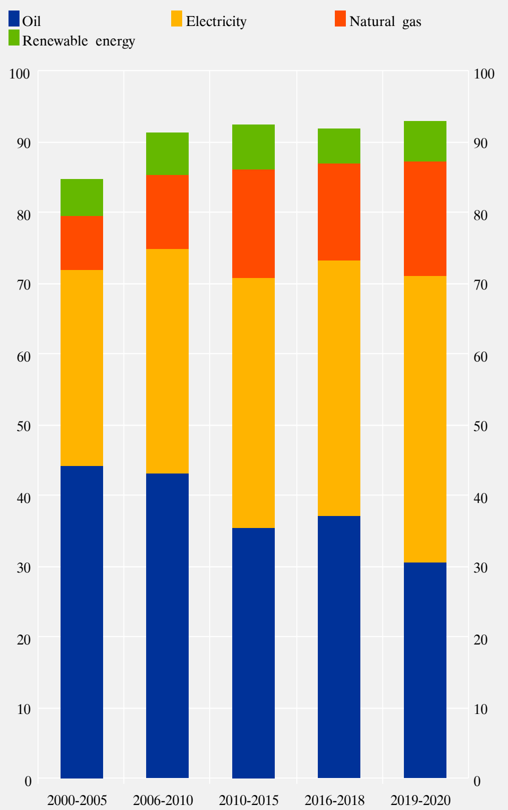
2.2 ENERGY CONSUMPTION IN THE INDUSTRIAL SECTOR AND EXPORTS OF NON-ENERGY GOODS IN GREECE

The relative paths of total final energy consumption and real exports of non-energy goods are shown in Chart 3 for the period 2000-2020. During 2000-12, total final energy consumption and real exports of goods moved in the same direction. From 2012 onwards, the two series diverge and the positive co-movement is interrupted. This is due to the decrease in final energy consumption, which is attributed mainly to the financial crisis (2009-17) and the COVID-19 crisis, but is also related to the implementation of the energy sector reforms. An analysis of the change in the energy mix by decomposing the evolution of each type of energy could help gain insight into the issue of the continued goods exports growth.

8 It should be noted that in 2020, the year when the COVID-19 crisis emerged, all types of energy consumption recorded a significant decrease in the EA. In Greece the consumption of natural gas and RE continued to rise.

Chart 4 Shares of energy consumption in industry by type of energy in Greece

(thousand tons of oil equivalent)



Sources: Eurostat and own calculations.
Note: Fossil fuels are not included in the chart since they account for a small share in total energy consumption over the sample period.

The evolution of the shares of the four most important types of energy (oil, natural gas, electricity and RE) in total final consumption in the industrial sector during the sample period in Greece is shown in Chart 4. The examination of changes in growth patterns in the industrial sector is relevant, since the energy consumed in industry is used in the production process of goods in manufacturing, part of which is exported. A general observation that is also verified visually is that the sum of the electricity, natural gas and RE shares has recorded an increase of 13 percentage points during the last two decades. The highest increase over this time was recorded in the shares of electricity and natural gas (almost equal, by 14 percentage points). The share of RE in total energy consumption in the industrial sector has increased modestly during the last four years, from 5% to 6%, which is lower than the corresponding share when total consumption in all sectors is considered (12%, as mentioned above).

However, during the five years following the financial crisis and subsequent recession of the period 2009-17, the growth rate of RE consumption has been increasing, reaching a 7% in industry, higher than that referring to the whole economy (4%). During the same time, electricity consumption in industry grew by 5%. A shift in the energy mix away from oil and fossil fuels[9] towards electricity, natural gas and RE —indicating a substitution of consumption— occurred in industry after 2016, and exports of goods exhibited a concomitant growth during this time.[10,11,12] Finally, the share of oil in total final consumption remained high in industry (above 30%, lower, however, than that seen when the whole economy is considered), even though it has dropped by 17%, which makes it second in importance, since the consumption of electricity has a prevalent role in industry.

3 LITERATURE REVIEW

The study of factors that affect export performance and export promotion has gained importance in recent decades since producing and exporting competitive products is a necessary prerequisite for a country to grow and prosper. The economic literature has focused on the estimation of export demand equations and real exports responsiveness to the changes in the real world income and a relative price ratio of a country's export prices over the world price, often approximated by the real effective exchange rates. Various econometric

9 Their share fell from 19% in 2000 to 6% in 2020.
10 The decrease in the share of oil is gradual throughout the sample and more intense in 2020 during the COVID-19 crisis.
11 In 2020, oil and electricity consumption covered more than two thirds of total energy consumption in industry.
12 During 2019-2020, RE consumption in industry increased by 12%, indicating a shift to consuming this type of energy during the COVID-19 crisis.

techniques have been used to estimate equations of exports at the aggregate, country, sectoral and firm levels. The recent trade literature has expanded the traditional approach to export demand estimation by relating export activity to additional factors other than the conventional ones (i.e. R&D in Benfratello 2022, non-price factors in Athanasoglou and Bardaka 2010) and attempts have been made to explore the links between exports and energy, drawing on recent concerns on environmental quality issues and the outbreak of the energy crisis.

There is, however, limited exploration of the relationship between final energy consumption and exports, while there is extensive work on the effects of energy consumption on growth since the pioneering study by Kraft and Kraft (1978). Energy economics is largely populated with research that explores the temporal relationship between energy and GDP and a branch deals extensively with its causal nature without reaching a definite conclusion yet. Various procedures have been used to estimate this relationship, initially in bivariate and then in multivariate models that have included energy and exports among other variables (see Ozturk and Acaravci (2011) for a review of the different hypotheses tested). Kahrl and Roland-Holst (2008), for example, claim that exports have been a primary driver of China's economic growth over the last decade. China has increased its relative energy usage in the exports of all technological categories of goods. Amador (2012) in a similar context compares the energy content in manufacturing exports of 30 advanced and emerging economies from 1995 to 2005, using input-output matrices of trade data for 17 sectors. He concludes that Brazil, India and, mostly, China present a high-energy content in manufacturing exports. Dedeoglu and Kaya (2013) investigate the relationships between energy use and GDP, energy use, exports and trade, and energy use and imports at the aggregate level in the OECD countries. By employing panel cointegration, they find the presence of a long-run relationship and two-way causality between energy use and GDP, energy use and exports, as well as energy use and imports.

Further, there is a literature strand on the electricity consumption-growth relationship and Payne (2010) offers a review. A related work by Bosupeng (2017) finds that among 40 economies, twenty-one exhibited statistically significant long-run relationships between exports, income and electricity consumption using the Johansen cointegration procedure. In addition, it is shown that exports and electricity consumption are statistically cointegrated in the long run for all economies based on the Saikkonen and Lutkepohl test. The existence of bidirectional causal relationships between exports and electricity consumption is confirmed.

Erkan, Mucuk and Uysal (2010) aim to determine the impact of domestic energy consumption on exports in Turkey. Using cointegration and Granger causality tests, they find a significant relationship between domestic energy consumption and exports in the long term. A Granger causality test shows that there is a unidirectional causality running from energy consumption to exports and the authors conclude that energy is an important factor for economic growth in the Turkish economy.

4 DATA, EMPIRICAL SPECIFICATION AND METHODOLOGY

The data on energy consumption and exports of non-energy goods comes from the Eurostat database. Final energy consumption – energy use – has been used, excluding consumption by the energy sector. Energy use considers the sum of consumption by all end-use sectors (e.g. transport, industry, residential, etc.).[13] EA real exports (chain-linked volumes, 2015) of oil and

13 Energy use is defined as the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself. Final energy consumption excludes energy used by the energy sector, including for deliveries, and transformation. It also excludes fuel transformed in the electrical power stations of industrial autoproducers and coke transformed into blast-furnace gas, where this is not part of overall industrial consumption but of the transformation sector.

petroleum products[14] were subtracted from real exports of goods (chain-linked volumes, 2015). Greece's oil exports at current prices (Eurostat SITC 33 series) were subtracted from exports of goods at current prices and the resulting series was converted to real terms using the goods producer price index (external economy, excluding energy, ELSTAT). External demand, proxied by world demand, and real effective exchange rate values were obtained from the ECB SDW database. The data is annual and covers the last two decades, i.e. the period 2000-2020.

Final energy consumption is total, broken down by type of energy and measured in thousand tons of oil equivalent. Five individual energy types are considered, which comprise the most demanded sources of energy:

- Fossil fuels (FCFOSS)
- Natural gas (FCNGAS)
- Oil (FCOIL)
- Renewable energy (FCREN)
- Electricity (FCELEC)

The equation to estimate is an export demand equation augmented with energy consumption:

$$\log(REXPGOODS)_t = \alpha_1 + \beta_1 * \log(WD)_t + \beta_2 * \log(REER)_t + \beta_3 * \log(Z)_t + e_t \quad (1)$$

We define $REXPGOODS_t$ as the dependent variable (real exports of goods excluding oil products) with independent energy variables denoted with Z_t, including the various types of energy consumption respectively: FCTOT (total consumption), FCFOSS, FCNGAS, FCOIL, FCREN, FCELEC. Finally, control variables include the conventional variables of an exports demand equation, such as foreign demand (WD_t) and the real effective exchange rates ($REER_t$).

Two approaches were adopted in order to estimate the long-run relationship between the variables of equation (1). First, the Johansen (1988) VECM cointegration procedure was used to estimate six separate equations, the first considering total energy consumption as an independent variable and another five equations using the consumption of each energy type, both for Greece and the EA. The second approach uses various panel estimators for the set of 19 EA countries to estimate equation (1). Individual effects for Greece are captured by a country dummy, which allows the comparison to the time-series approach in order to check the robustness of our results. The panel estimation has the advantage that it does not suffer from the degrees of freedom problem, which burdens the estimation for each country separately, and thus it produces more efficient and consistent estimates.

For the panel estimation three methods were used: 1) the fixed effects method, which provides pooled panel estimates of the coefficients and improves efficiency by considering separate effects for each cross section; 2) the DOLS (dynamic ordinary least squares) method; and 3) the PMG (pooled mean group) method, of which the last two are panel cointegration, error-correction methods. The fixed effects methodology allows for cross section effects, but does not correct for possible non-stationarity in the series. The inclusion of an autoregressive coefficient in each equation improves efficiency, but this approach is inferior to the other two in terms of bias. The DOLS and PMG methods estimate a long-run cointegrating relationship. DOLS was originally developed by Phillips and Loretan (1991), Saikkonen (1991) and Stock and Watson (1993) for a single equation, and extended by Kao and Chiang (2000) for panel data. The method takes into account the dynamic nature of variables (i.e. integration of order 1) and pools the panel data to generate the estimated coefficients, allowing the constant and the trend to differ and to account for cross-section

14 Converted to real terms by dividing by real oil prices. Nominal prices in USD from the World Bank: Commodity Price Data are converted to euros by dividing by the USD/EUR exchange rate. Real oil prices are obtained by dividing by the EA implicit GDP price deflator.

heterogeneity. The PMG procedure calculates the pooled mean group (PMG) estimator for dynamic panel data according to Pesaran, Shin and Smith (1999). This estimator allows the intercepts, short-run coefficient and error variances to differ freely across groups, but restricts the long-run coefficients to being equal across cross sections. A long-run relationship is derived along with the short-run error correction equation.[15]

5 EMPIRICAL RESULTS: GREECE COMPARED TO THE EURO AREA

Table 1 summarises the descriptive statistics for each of the variables in the sample used for the single equation estimation.

Prior to the estimation of the long-run equations, unit root tests were carried out to find out the order of integration for each of the series included in equation (1) for both Greece and the EA. For the single equation, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1981) results are presented in Table 2. It is verified that all the series are integrated of order one, I (1). For the panel data, the Levin, Lin & Chu (2002, LLC) and Breitung (2000) panel unit root tests have been used, which are based on cross-sectional independence. The results are presented in Table 3.[16] The null hypothesis of non-stationarity fails to

15 DOLS and PMG do not take into account cross-sectional dependence that may be present in a panel dataset.
16 The tests assume that there is a common unit root process across the panel members (e.g. cross sections are homogeneous).

Table 1 Descriptive statistics

	a. Euro area								
	REALEXPEA	FCTOTEA	FCFOSSEA	FCNGASEA	FCOILEA	FCELECEA	FCRENEA	WDEA	REERULCT
Mean	2861764.60	757566.37	10787.37	175605.45	310691.97	170157.85	55518.27	3.32	94.58
Median	2879561.99	748656.69	10326.63	175540.78	308085.41	172114.23	58171.95	3.34	96.49
Maximum	3746069.88	799427.79	15175.86	189000.05	352359.39	177568.54	73505.77	4.55	108.48
Minimum	1976067.50	690156.71	7030.32	158588.55	249261.79	153912.82	33002.65	1.96	84.47
Std. Dev.	552193.80	29851.55	2296.89	8419.55	31976.57	6323.72	13407.62	0.84	7.30
Skewness	-0.05	-0.29	0.35	-0.19	-0.05	-1.12	-0.41	-0.26	0.14
Kurtosis	1.89	2.49	2.18	2.14	1.66	3.48	1.83	1.82	1.70
Jarque-Bera	1.08	0.53	1.02	0.78	1.58	4.61	1.79	1.45	1.54
Probability	0.58	0.77	0.60	0.68	0.45	0.10	0.41	0.48	0.46
Sum	60097056.50	15908893.67	226534.85	3687714.39	6524531.33	3573314.94	1165883.68	69.79	1986.13
Observations	21	21	21	21	21	21	21	21	21

	b. Greece							
	REALEXPGR	FCTOTGR	FCFOSSGR	FCNGASGR	FCOILGR	FCELECGR	FCRENGR	WDGR
Mean	18548.14	17717.66	382.40	744.59	10842.15	4353.15	1345.37	3.46
Median	17828.02	18185.33	281.63	811.55	11427.57	4366.90	1340.43	3.52
Maximum	23552.54	21120.90	892.65	1097.87	13840.67	4870.68	1726.92	4.59
Minimum	15638.18	14482.86	167.42	257.25	7351.32	3710.32	1081.42	2.30
Std. Dev.	2622.38	2269.64	229.08	258.00	2427.47	294.93	223.24	0.73
Skewness	0.62	-0.04	1.04	-0.55	-0.11	-0.37	0.43	-0.18
Kurtosis	1.94	1.48	2.91	2.15	1.30	2.71	1.80	1.93
Jarque-Bera	2.32	2.02	3.83	1.69	2.58	0.55	1.90	1.12
Probability	0.31	0.36	0.15	0.43	0.27	0.76	0.39	0.57
Sum	389511.0	372070.90	8030.48	15636.45	227685.16	91416.10	28252.79	72.68
Observations	21	21	21	21	21	21	21	21

Table 2 ADF unit root tests – Variables in levels

	Greece	Euro area
REALEXP	-2.438 (0.145)	-1.200 (0.653)
FCTOT	-0.123 (0.934)	-0.130 (0.932)
FCFOSS	-3.589* (0.017)	-0.603 (0.864)
FCNGAS	-1.504 (0.511)	-2.320 (0.175)
FCOIL	0.167 (0.963)	0.558 (0.984)
FCELEC	-2.312 (0.178)	-2.925* (0.060)
FCREN	-0.753 (0.810)	-1.189 (0.657)
WD	-1.367 (0.577)	-1.425 (0.549)
REERULCT	-1.546 (0.490)	

Notes: The standard ADF test statistics are reported for the null hypothesis of the existence of a unit root of the variables included in the single equation model. Numbers in parentheses are p-values. The 1% and 5% asymptotic critical values are -3.808 and -3.020 and are from Mackinnon (1996).

Table 3 Panel unit root tests

	LLC	Breitung
REALEXP	2.375 (0.991)	-0.572 (0.284)
FCFOSS	-0.878 (0.189)	1.406 (0.920)
FCNGAS	0.472 (0.682)	-0.524 (0.300)
FCOIL	-0.476 (0.317)	2.296* (0.989)
FCELEC	-0.851 (0.197)	2.991 (0.998)
FCREN	-1.897* (0.029)	-0.331 (0.370)
WD	0.604 (0.727)	3.804* (0.999)
REERULCT	0.088 (0.535)	0.238 (0.594)

Notes: LLC and Breitung are the Levin, Lin & Chu (2002) and Breitung (2000) tests, respectively. The reported tests use a constant and a trend. All the test statistics follow the normal distribution. Variables are in logarithms. The * mark denotes the rejection of the null hypothesis of non-stationarity at the 5% level of significance. Numbers in parentheses are p-values.

Table 4 Panel cointegration tests

Pedroni tests	eq. 2	eq. 3	eq. 4	eq. 5	eq. 6
H_0: There is no cointegration					
H_1: Common AR coefficients					
Panel v	1.366* (0.086)	-2.177 (0.985)	2.813* (0.002)	0.073 (0.471)	1.963* (0.025)
Panel ϱ	-0.069 (0.472)	-1.526* (0.063)	1.779* (0.962)	0.292* (0.615)	0.117* (0.547)
Panel PP	-1.417* (0.078)	-4.438* (0.000)	0.266 (0.605)	-1.977* (0.024)	-1.301* (0.096)
Panel ADF	-2.062* (0.019)	-4.398* (0.000)	-1.270* (0.102)	-3.151* (0.000)	-1.598* (0.055)
H_1: Individual AR coefficients					
Group ϱ	1.685 (0.954)	0.558 (0.711)	3.663 (0.999)	2.350 (0.991)	1.484 (0.931)
Group PP	-0.409 (0.341)	-4.209* (0.000)	-2.526* (0.006)	-3.890* (0.000)	-0.919 (0.179)
Group ADF	-1.719* (0.043)	-4.661* (0.000)	-0.934 (0.175)	-4.087* (0.000)	-1.465* (0.071)

Notes: The * mark indicates rejection of the null hypothesis of no cointegration at the 10% level of significance. Numbers in parentheses are p-values. The Pedroni tests follow the normal distribution. PP and ADF stand for Phillips-Perron and Augmented Dickey Fuller, respectively. The critical values from Pedroni (1999) have been used. The notation eq. 2 to eq. 4 represents equation (1) using each of the five energy types.

Table 5 VECM long-run elasticities of exports of goods 2000-2020: Greece and euro area

(dependent variable: real exports of non-oil goods)

Equation	Independent variables	Greece	Euro area	Greece H_0: There is no cointegration H_1: There is at most one cointegration vector		Euro area H_0: There is no cointegration H_1: There is at most one cointegration vector	
				Trace	λmax	Trace	λmax
1	FCTOT	1.327** (17.5)	1.209** (52.3)	71.42*** 40.50	30.94 22.22	57.68** 24.45*	33.23* 16.46
2	FCFOSS	0.841** (9.212)	0.499* (2.055)	95.79*** 46.65***	49.14*** 25.66	82.17*** 44.86***	37.31† 18.01
3	FCNGAS	0.761** (5.660)	1.392** (21.55)	90.49*** 45.68***	44.81** 28.16	62.27** 32.71	29.56* 22.54*
4	FCOIL	1.829** (25.2)	1.466** (16.97)	92.62*** 30.24***	62.37*** 21.69	56.60* 30.02	26.60 17.90
5	FCELEC	1.830** (5.125)	1.367** (35.99)	80.85*** 35.39	45.46*** 18.99	56.60** 29.10	27.50 18.46
6	FCREN	1.712** (9.679)	0.455** (8.738)	67.79*** 35.71	32.01* 16.03	73.15* 37.52*	35.63* 19.34
1	WD	0.877** (7.027)	0.809** (45.2)				
2	WD	2.010** (5.124)	0.829** (4.461)				
3	WD	0.482* (1.817)	0.987** (11.38)				
4	WD	1.257** (19.38)	0.933** (18.95)				
5	WD	1.553** (5.034)	0.445** (10.14)				
6	WD	0.700** (3.057)	0.347** (7.498)				
1	REER	-0.906** (5.101)	-0.540** (7.857)				
2	REER	-0.148* (-1.945)	-0.112* (-1.492)				
3	REER	-4.299** (-14.188)	-0.665** (-3.597)				
4	REER	-1.885** (-11.667)	-1.046** (-4.241)				
5	REER	-1.491** (-2.387)	-0.470** (-4.474)				
6	REER	-0.639* (-2.095)	-0.266** (-4.355)				

Notes: t statistics are in parentheses and the *, **, *** and † marks indicate statistical significance at the 10%, 5%, 1% and 2.5% levels of statistical significance, respectively. For the trace and max eigenvalue tests the critical values from Osterwald-Lenum (1992) have been used. Equation 1 to 6 represents the estimated equation including each energy type separately due to the small size of the sample. The real effective exchange rate is calculated using unit labour costs for the whole economy and a group of 19 trading partners of the EA. Dummies were used for the years of the financial and the COVID-19 crises.

be rejected in each case and the panel series are non-stationary.

Testing for the existence of cointegration among the variables of equation (1) is necessary in order to determine if the variables share a common trend, which will then be estimated. Table 4 reports the panel cointegration tests of Pedroni (1999). The null hypothesis of no cointegration is tested against alternative hypotheses that allow for heterogeneity among the 19 countries of the panel. The first four of the Pedroni tests pool the autoregressive coefficients across countries assuming homogeneity

Table 6 Granger causality tests

Equation	H_0	Test statistic	
		Greece	Euro area
1	Δ(FCTOT) does not cause Δ(REXPGOODS)	0.684 (0.408)	2.882* (0.090)
1	Δ(REXPGOODS) does not cause Δ(FCTOT)	0.702 (0.401)	0.002 (0.962)
2	Δ(FCFOSS) does not cause Δ(REXPGOODS)	3.044* (0.081)	0.001 (0.976)
2	Δ(REXPGOODS) does not cause Δ(FCFOSS)	3.455* (0.006)	0.119 (0.729)
3	Δ(FCNGAS) does not cause Δ(REXPGOODS)	0.473 (0.491)	3.215* (0.073)
3	Δ(REXPGOODS) does not cause Δ(FCNGAS)	1.893 (0.168)	2.004 (0.157)
4	Δ(FCOIL) does not cause Δ(REXPGOODS)	3.586* (0.058)	2.012 (0.156)
4	Δ(REXPGOODS) does not cause Δ(FCOIL)	2.315 (0.128)	1.030 (0.310)
5	Δ(FCREN) does not cause Δ(REXPGOODS)	0.002 (0.962)	0.401 (0.526)
5	Δ(REXPGOODS) does not cause Δ(FCREN)	0.875 (0.349)	1.593 (0.206)
6	Δ(FCELEC) does not cause Δ(REXPGOODS)	0.277 (0.598)	0.602 (0.647)
6	Δ(REXPGOODS) does not cause Δ(FCELEC)	4.461* (0.035)	0.004 (0.949)

Notes: The test statistic is χ^2 with 1 degree of freedom. The * mark denotes significance (i.e. Granger causality) at the 10% level of significance. Numbers in parentheses are p-values. Equation 1 to 6 represents the estimated equation including each energy type separately due to the small size of the sample.

of panel members, in our case the 19 EA countries. The next three tests allow the first-order autoregressive term to vary across countries. The null hypothesis of no cointegration is rejected, according to all panel and group tests with the exception of the group ϱ test. The consistence in rejecting the null hypothesis suggests that the series in the panel can be grouped and exhibit some homogeneity, which is in line with the adoption of the PMG and DOLS estimators.[17] Table 5 presents the cointegration tests of the single series VECM estimation of the goods exports demand equation for the final consumption of each of the five types of energy considered here for Greece and the EA. The reported trace and maximum eigenvalue test statistics in all cases indicate the existence of a long-run relationship and one long-run cointegration vector. Thus, exports of goods depend on total final energy consumption and on the consumption of each of the five energy types considered here.

Table 6 presents the estimated long-run elasticities with respect to the energy variables and the control variables WD_t and $REER_t$ that capture the effects of external demand and real effective exchange rates. All variables are found to be statistically significant and their signs are in accordance with theory. The elasticities with respect to total consumption do not differ significantly when comparing Greece to the EA. In both cases they are close to unity, indicating that a 10% increase in energy consumption is associated with a

17 However, as has been pointed out, these tests are based on the assumption of independent panel members. Because of common shocks, this condition is hardly fulfilled in applied work. It is known that panel unit root tests and cointegration tests have been developed to control for the panel member dependencies, but they lie beyond the scope of this study.

broadly equal percentage increase in the exports of goods.

Concerning the individual effect of the consumption of each type of energy on exports of goods, presented in the same table, a general observation is that the respective elasticities are statistically significant and all above unity, except for the effect of the consumption of renewable energy in the EA, natural gas in Greece and fossil fuels both in Greece and the EA, where exports have an inelastic response. The elasticities for Greece concerning the effect of the final consumption of oil, electricity and RE are above the EA average estimates. Specifically, in Greece exports increase by 18.3% and 17.2% in response to a 10% increase in final consumption of electricity and RE, respectively (VECM estimates). Thus, the increases in the final consumption of electricity and RE observed in our sample contribute to increased goods exports and partly explain their above-mentioned growth.[18] A response of goods exports to electricity consumption of almost unit elasticity is also found in the panel estimation in Table 7, considering Greece separately[19] (based on DOLS).

In addition, referring to the VECM estimates, the export demand elasticities with respect to oil, electricity and RE final consumption in Greece are similar in size. An increase in the consumption of each of these energy types has a broadly equal impact on exports of goods. The coefficient of electricity consumption is slightly higher compared to the other two coefficients, possibly reflecting the shift away from the consumption of oil and towards consuming electricity. Finally, the coefficient of the consumption of natural gas is lower, suggesting that an exogenous reduction in the consumption of natural gas could have a more muted impact on exports.

Regarding the EA average, final consumption of natural gas, oil and electricity have the highest and similar in size coefficients, according to both VECM and panel estimates (see Table 5). According to the panel estimation results based on the PMG and DOLS methods, the final consumption of gas and electricity have the highest effect on goods exports. The coefficients resulting from both approaches show a proportional or slightly above proportional effect (coefficients are unity in the PMG and DOLS methods and 1.4 in the VECM estimation). These findings are consistent with the high shares of electricity and natural gas in total final energy consumption (both close to 24%) reported in Section 2.1. The effect of fossil fuel consumption on exports of goods is small in both Greece and the EA, according to both methodologies, which is consistent with the significant reduction in the share of fossil fuels in total consumption in the EA and in the EU in general.

Furthermore, based on both VECM and panel estimation, the elasticity of the impact of consumption of RE is significantly higher in Greece than in the EA (1.712 and 0.455, respectively in the VECM, while in the panel estimation it ranges from 0.2 to 0.4 for Greece and from 0.03 to 0.06 for the EA). This finding indicates the increasingly important role of RE consumption in the evolution of exports of goods. It is also related to the shift of the energy mix towards RE during recent years in Greece, described in Section 2, which highlights the positive contribution of "green" forms of energy to the production of exported goods. According to these results, Greece already enjoys the advantages of this shift. A comparative advantage – also associated with climate conditions – can be obtained through significant investments, e.g. in wind turbines or solar energy through photovoltaic systems, which have acquired a significant market share. If maintained, these efforts should increase the country's autonomy in times when energy has become more expensive.

A question often asked by researchers concerns the existence of a causal relationship

18 The coefficient of natural gas consumption for Greece is lower (below unity) than that for the EA.

19 These correspond to the respective independent energy variable after multiplying with a dummy variable, which is unitary for Greece and zero elsewhere.

Table 7 Panel estimation of 19 euro area countries: 2000-2020

(dependent variable: real exports of non-oil goods)

Equation	Independent variables	Fixed effects	DOLS	PMG	ECM_{t-1}
2	FCFOSS	0.024** (1.846)	0.066* (1.627)	0.473*** (3.873)	-0.074** (-2.007)
3	FCNGAS	0.173*** (3.592)	0.932*** (11.748)	1.133*** (5.880)	-0.178*** (-3.365)
4	FCOIL	0.145** (2.451)	0.497*** (3.904)	0.844*** (6.458)	-0.143*** (-2.853)
5	FCELEC	0.899*** (5.561)	0.989*** (2.693)	1.092*** (4.107)	-0.191*** (-5.502)
6	FCREN	0.050*** (3.093)	0.029*** (2.595)	0.059* (1.562)	-0.138*** (-5.704)
2	WD	1.178*** (16.308)	1.277*** (5.660)	1.464*** (8.499)	-
3		1.012*** (14.929)	1.046*** (16.60)	0.355** (2.197)	-
4		0.925*** (12.90)	0.933*** (12.87)	0.821*** (16.49)	-
5		0.707*** (12.19)	0.467*** (2.979)	0.557*** (8.983)	-
6		1.054*** (15.47)	0.917*** (15.29)	0.814*** (14.20)	-
2	REER	-0.141** (-1.795)	-0.358** (-2.299)	-1.227*** (-3.454)	-
3		-0.153** (-1.939)	-	-0.929*** (-5.812)	-
4		-0.171** (-2.360)	-0.469** (-2.261)	-0.549*** (-5.313)	-
5		-0.375** (-2.105)	-0.708** (-2.453)	-1.566*** (-8.415)	-
6		-0.124* (-1.605)	-0.175*** (-2.896)	-0.570*** (-11.69)	-
2	Coefficient for Greece	0.061 (0.733)	0.204** (1.997)	-	-
3		0.175** (1.736)	0.359** (1.944)	0.676*** (4.785)	-0.229*** (-3.839)
4		0.437*** (3.699)	0.595** (2.043)	1.101*** (52.9)	-0.083** (-2.322)
5		0.663** (2.349)	0.860** (1.864)	-	-
6		0.315** (1.695)	0.419** (1.712)	0.194*** (6.403)	-0.287*** (-4.261)
2	RMS	0.056	0.078	0.057	-
3		0.061	0.570	0.046	0.045 [0.052]
4		0.070	0.143	0.041	0.041 [0.061]
5		0.174	0.119	0.049	0.049 [0.056]
6		0.095	0.051	0.058	0.057 [0.051]

Note: t statistics in parentheses. The ***, **, and * marks indicate statistical significance at the 1%, 5% and 10% levels of statistical significance, respectively. The last column reports RMS for the EA average error correction equation and numbers in brackets are the corresponding RMS for the error correction equation considering Greece separately. Dummies were used for the years of the financial and the COVID-19 crises.

between the variables involved in the estimation. Finding a statistically significant long-run relationship between goods exports and the independent variables in equation (1) does not provide information about the direction of causality between exports and energy. Table 6 presents the relevant Granger causality tests performed for Greece and the EA. Total consumption Granger causes exports of goods in the EA, since the χ^2 statistic referring to eq. 1 in Table 6 is statistically significant. The consumption of oil and natural gas Granger causes exports of goods in Greece and the EA, respectively (eq. 4 and eq. 3 in Table 6). These findings lead to the conclusion that oil and natural gas consumption are important drivers of exports of goods in both Greece and the EA.

Regarding Greece, unidirectional reverse causality is found to run from real exports of goods to electricity consumption. This implies that exports of goods determine the amount of electricity needed for these goods to be produced. In other words, there are satisfactory amounts of electricity available for the production of exported goods. This result is probably related to the country's efforts to change the energy mix in electricity production by shifting away from imported natural gas (National Energy and Climate Plan, NECP, 2019). A study commissioned by the Hellenic Wind Energy Association (2021) shows that in periods of high penetration of RE (wind and photovoltaic energy) in the electrical grid, prices in the wholesale electricity market decrease significantly. Thus, the increases in electricity consumption observed in recent years are related, among other things, to falling electricity prices.[20]

Furthermore, there is a feedback relationship in the case of fossil fuels. This bidirectional causal relationship between goods exports and the consumption of fossils fuels may have a dual implication. First, the availability of consumption of this energy type is important for the production of exported goods. Second, the feedback, implying adequate available quantities, which is found between fossil fuels consumption and goods exports, may be due to the lower consumption levels and the shift away from the use of this type of energy.

Table 7 also reports the error-correction term derived from PMG. The error correction coefficient that corresponds to natural gas, oil and electricity consumption is relatively low, ranging from -0.1 to -0.2, indicating adjustment in 5 years for Greece as well as the EA. The error correction coefficient in the equation that uses RE is higher for Greece than for the EA, showing a faster adjustment towards the long-run equilibrium. For Greece the adjustment takes about 3 years, while for the EA equilibrium is reached in 5 years. This is another indication of the increased importance of RE consumption in explaining goods exports in Greece compared to the other countries of the EA.

6 CONCLUSIONS

Greece is typically an energy importer, although its resources allow the production of electricity and RE. Total final energy consumption decreased in the last decade, reflecting the financial and the COVID-19 pandemic crises and, to a smaller extent, the contraction of fossil fuel and oil consumption due to comprehensive energy sector reforms. Electricity and RE consumption, on the other hand, have grown during the last decade and gas entered the energy market in the beginning of the last decade of the sample period. Oil consumption still has a high share in total energy consumption, but the share of fossil fuels has become small.

The estimated elasticities of the exports of goods with respect to total energy consumption and the consumption of each energy type reflect these developments. A positive relationship is detected between exports of goods and final energy consumption and it is shown

20 In 2021, Greece ranked 7th in the world in the use of RE to produce electricity. According to the World Economic Forum (2022), "all of the increased electricity demand during the first half of 2022 was met by renewable energy" at the global level.

that in Greece goods exports depend on oil, electricity and RE consumption, while the respective elasticities are higher than those corresponding to the EA. The electricity consumption effect is relatively larger. This result is also verified by the panel estimation regarding Greece. Reverse causality is detected for this energy type, possibly associated with its high growth rates in recent years. Causality tests show a causal link between exports of goods and final oil consumption in Greece and exports of goods and final natural gas consumption in the EA. Finally, Greece's goods exports are found to have a higher dependence on RE consumption than the EA's, which is related to the recent higher growth of RE consumption. Accelerating the energy transition has become even more important in the EU and Greece with the emergence of the energy crisis. However, prospects are not as favourable, since RE projects may be difficult to finance in the current high inflation and rising interest rate environment. The RE sector is affected by underinvestment, driven by the general uncertainty about future demand, social and political factors. This negative outlook may have consequences on the upward course of goods exports.

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WORKING PAPERS
(AUGUST – DECEMBER 2022)

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CONTENTS

New facts on consumer price rigidity in the euro area

Working Paper No. 302

Erwan Gautier, Cristina Conflitti, Roemer P. Faber, Brian Fabo, Ludmila Fadejeva, Valentin Jouvanceau, Jan-Oliver Menz, Teresa Messner, Pavlos Petroulas, Pau Roldan-Blanco, Fabio Rumler, Sergio Santoro, Elisabeth Wieland and Hélène Zimmer

Using CPI micro data for 11 euro area countries covering about 60% of the euro area consumption basket over the period 2010-2019, the authors document new findings on consumer price rigidity in the euro area: (i) each month on average 12.3% of prices change, which compares with 19.3% in the United States; however, when price changes due to sales are excluded, the proportion of prices adjusted each month is 8.5% in the euro area versus 10% in the United States; (ii) differences in price rigidity are rather limited across euro area countries, but much larger across sectors; (iii) the median price increase (resp. decrease) is 9.6% (13%) when including sales and 6.7% (8.7%) when excluding sales; cross-country heterogeneity is more pronounced for the size than for the frequency of price changes; (iv) the distribution of price changes is highly dispersed: 14% of price changes in absolute values is lower than 2%, whereas 10% is above 20%; (v) the overall frequency of price changes does not change much with inflation and does not react much to aggregate shocks; (vi) changes in inflation are mostly driven by movements in the overall size; when decomposing the overall size, changes in the share of price increases among all changes matter more than movements in the size of price increases or the size of price decreases. These findings are consistent with the predictions of a menu cost model in a low inflation environment where idiosyncratic shocks are a more relevant driver of price adjustment than aggregate shocks.

Banking union: state of play and proposals for the way forward

Working Paper No. 303

Kornilia Vikelidou and Athanasios Tagkalakis

This paper examines the current state of play of the Banking Union project, aiming at unveiling the weaknesses and gaps of this still incomplete framework. In this context, the implementation, so far, of the Banking Union legislation sheds light on the vulnerabilities concerning supervisory change, transparency, trust and a proper allocation of bank failure costs since all these criteria are deemed as essential contributing factors to promoting financial stability at the European level. Taking into consideration the latest steps towards completing the Banking Union framework until June 2022, this paper aims at depicting the proposed leeway potentially capable to align resilience and flexibility, with a view to mitigating any persisting shock-amplifying factor against financial stability.

Public and private liquidity during crises times: evidence from Emergency Liquidity Assistance (ELA) to Greek banks

Working Paper No. 304

Antonis Kotidis, Dimitris Malliaropulos and Elias Papaioannou

In a surprise move during a crisis, the ECB excluded Greek government bonds from the set of eligible collateral in monetary policy operations. In turn, Greek banks turned to

Emergency Liquidity Assistance (ELA) to meet their funding needs. ELA replenished losses from all funding sources, consistent with its role as lender of last resort (LOLR). However, in anticipation to a switch to ELA, banks reduced their interbank and corporate lending as a result of its higher cost and conditionality. Although multi-lender firms compensated for the associated credit crunch, single-lender firms that were not able to establish new lending relationships experienced a reduction in their exports.

The effects of fiscal institutions on fiscal adjustments

Working Paper No. 305
Christos Chrysanthakopoulos and Athanasios Tagkalakis

Using a panel of 40 advanced economies over the period 1990-2020, this paper investigates the effect of various characteristics of fiscal councils and fiscal rules on the probability of starting a fiscal adjustment, as well as on the probability that this fiscal adjustment will be successful. The relevance of fiscal institutions' characteristics is verified when considering alternative definitions of successful fiscal adjustments. The results of the paper are robust after controlling for endogeneity of fiscal institutions' characteristics (by the Augmented Inverse Probability Weighted estimator) with fiscal adjustments. The authors find that a fiscal rule with a well-specified escape clause, which has multi-year expenditure ceilings and excludes public investment, can induce a successful fiscal adjustment. A fiscal council with enhanced remit, independence and accountability and with extended tasks and instruments increases the probability of successful fiscal adjustments. Finally, the authors find that a fiscal council with extended tasks and instruments increases the probability of successful fiscal adjustments based on spending cuts.

The short-term effects of structural reforms and institutional improvements in OECD economies

Working Paper No. 306
Christos Mavrogiannis and Athanasios Tagkalakis

Using a panel of 37 OECD countries over the period 1990-2019, the authors examine the short-to-medium-term effect of structural reforms and governance or institutional improvements on growth. Employing an updated OECD dataset on product and labour market regulation as well as governance indicators from the World Bank and after controlling for the endogeneity of reforms via the augmented inverse probability weighting (AIPW) method, they find that it is governance or institutional improvements (such as in government effectiveness, regulatory quality and rule of law) that have positive growth effects on real GDP in most cases. Labour market reforms do have positive growth effects under specific conditions, i.e. at times of recession, better governance, low indebtedness, low trade openness, high employment rate and tight monetary policy. Product market reforms have negative growth effects at most times and states considered. However, the authors find that countries with better governance quality and deregulated labour markets can reap significant benefits from them.

Milton Friedman and the road to monetarism: a review essay

Working Paper No. 307
George S. Tavlas

The objective of Ed Nelson's two-volume book, Milton Friedman and Economic Debate in the United States, 1932-1972, is to provide an account of Friedman's views in major monetary-policy debates during the period identified in the book's title. Nelson tells the story of the development of Friedman's monetary framework, from its Keynesian origins in the early-1940s to its gradual absorption of monetary factors in the late-1940s and, finally, to its monetarist character of the 1950s and after, through the windows of a selection of debates that engaged Friedman. At the same time, Nelson places Friedman's monetary contributions within the context of the modern macroeconomics literature. In this essay, the author considers doctrinal issues related to Nelson's account of the development of Friedman's monetarist framework.

The short-run effects of fiscal adjustment in OECD countries

Working Paper No. 308
Georgios Georgantas, Maria Kasselaki and Athanasios Tagkalakis

This paper investigates the short-run effects of fiscal adjustment shocks on macroeconomic aggregates in a group of 24 OECD economies from 1990 to 2019. The analysis controls for recession and expansions, high and low public debt ratio, tight and loose monetary conditions, and trade openness. The auhtors find no evidence of expansionary fiscal consolidations or non-Keynesian effects. The empirical findings suggest that unanticipated fiscal consolidation shocks lead to lower real GDP, private consumption, investment, and inflation and to higher unemployment rate. The effects are more pronounced in bad economic times, high-debt countries, closed economies and when monetary conditions are tight. Consequently, in these cases, the decline of the public debt ratio is more subdued.

Drivers and spillover effects of inflation: the United States, the euro area, and the United Kingdom

Working Paper No. 309
Stephen G. Hall, George S. Tavlas and Yongli Wang

The authors investigate the drivers of the recent inflation in three currency areas: the United States, the euro area, and the United Kingdom. To do so, they use a VAR set-up to examine the nature of the shocks that underpinned the recent inflation. They apply two methods to calculate shocks – the standard Cholesky decomposition and a new method that captures more realistic shocks by solving the VAR backwards. The authors also use spatial modelling to investigate cross-country inflation spillovers. They find that the inflationary shocks in the United States are transmitted to the euro area and the United Kingdom in a powerful and consistent way. The euro area transmits inflation to the other regions but to a lesser extent, while the inflation in the United Kingdom has little effect on the other two regions.

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