Operational Research (2023) 23:66
https://doi.org/10.1007/s12351-023-00807-4

ORIGINAL PAPER

Assessing the efficiency of occupational pension funds in Greece

Chrysanthopoulou Xakousti[1] · **Mavrommati Athanasia**[2] · **Migdalas Athanasios**[3]

Received: 10 July 2023 / Revised: 30 September 2023 / Accepted: 6 November 2023

Abstract
In countries like Greece where long-term fiscal imbalances and bailouts are to a large extent attributed to particularly high pension expenditures as a share of Gross Domestic Product (GDP), (e.g., 15.5% of GDP in 2017) (pre)funded pension schemes are expected to play an important role. This is the first study that analyzes the technical efficiency of occupational pension schemes in Greece by applying the methodology of Data Envelopment Analysis on a sample of sixteen decision-making units for the period 2017–2020. The study also provides up-to-date information on the spread of occupational pension schemes in Greece. The results indicate that one out of two Greek occupational pension funds operated fairly efficiently and that the sector displayed a considerable variation and a systematic upward trend. Total equity and debt are the main determinants of occupational pension funds' efficiency, followed by total assets and operating expenses. Furthermore, scale acts as a restriction on the efficient performance of small occupational pension funds. These findings imply a need for resource reallocation (e.g., reduction of the level of inputs used) and for favoring economies of scale (e.g., through the operation of 'open' pension funds).

Keywords Data envelopment analysis · Greece · Occupational pension funds · Pension system · Technical efficiency

1 Introduction

Unfavorable demographic trends and the related problem of fiscal imbalances have led many countries around the world to implement multi-pillar pension systems combining—to different degrees—the redistributive and funded schemes (World Bank 1994; Holzmann et al. 2003; Ebbinghaus 2011; OECD 2018b).[1] Despite EU

[1] Occupational schemes (pillar II) and statutory public schemes (pillar I) aimed at avoiding old age poverty should ensure pension adequacy (that is prevention of poverty in old age, inter-generational soli-

Extended author information available on the last page of the article

attempts to significantly increase the role of occupational pension funds (pillar II)—through Institutions for Occupational Retirement Provision (IORP) Directives I and II (EU Directive 2003/41/EC, 2016/2341)—there is still considerable divergence across European countries. Southern European countries still lag behind Continental, Anglo-Saxon, and Nordic countries. And maybe this is the reason why the issue of occupational pension funds in Southern European countries has not received particular attention in the literature.

This study focuses on occupational pension funds in Greece. In particular, the study aims to assess the performance of this sector. The choice of this country is not random. The justification is threefold. First, the Greek pension system relies almost exclusively on pillar I (pay-as-you-go, henceforth PAYG). Contributions to funded pensions in Greece were 10 times less than the relevant OECD average in 2018 (Pissarides et al. 2020). Furthermore, the Greek pension system has been distortive, costly, and inefficient (Tinios 2016; Christodoulakis 2018; European Comission June 2020; Kangur et al. 2021). Second, circumstances have changed; the occupational pension funds sector displays a systematic upward trend in recent years, while the first auxiliary funded pension scheme starts operation in January 2022. Third, occupational pension schemes in Greece are expected to improve various macroeconomic variables. The Foundation for Economic and Industrial Research (FEIR) estimates that from the further development of the Greek pillar II new capital reserves (exceeding 10% of the GDP) will emerge and that GDP will increase by up to €2,7 billion (FEIR 2022).

This enhanced role of funded, that is, occupational pension plans, raises issues concerning efficiency and performance. Understanding the efficiency of occupational pensions in Greece is important for various reasons: An efficient occupational pension sector is critical to proper management of risk, encourages long-term saving by redirecting funds from insured persons towards investments, enhances competition, and raises the trust of the insured persons. Moreover, as the rules laid down in IORP II (2016/2341) 'intended to clear the way for the sound, prudent and *efficient* management of occupational pension schemes', this study adds to the literature by providing additional information on the performance of the Greek pillar II after the implementation of the IORP II. In addition, efficiency in occupational insurance is of great importance for the current time due to the challenges faced by pillar II in Greece, that is, the low economic environment, low returns in traditional asset classes, and low-interest rates.

Nevertheless, it is still not estimated whether the Greek occupational pension sector, an additional 'saving vehicle', is efficient or not, and if so, to what extent it is. In the academic literature, there has been little attention to occupational pension funds in medium-sized and smaller pension markets. Most studies focus on important pension markets, like The Netherlands or The United Kingdom, but largely ignore for

Footnote 1 (continued)
darity, and the maintenance of living standards in old-age), leaving personal saving schemes (pillar III), mandatory or voluntary, as a tool for individuals to enhance their replacement rates (European Parliament 2014).

example Southern Europe or Central and Eastern Europe countries as they were characterized by a very limited, if almost nonexistent, role of occupational welfare (see, for example, Ebbinghaus 2011; Pavolini and Seeleib-Kaiser 2018). To the best of the authors' knowledge, no previous study has investigated the performance of Greek occupational pension schemes. Therefore, we only have limited knowledge of the market dynamics in Greece.

The novelty of our contribution is twofold. First, we want to address this literature gap and stimulate further research on the efficiency of the Greek second pillar by examining the technical efficiency of sixteen occupational pension funds, that is, four mandatory and twelve non-compulsory, for the period 2017–2020, by applying Data Envelopment Analysis (DEA). Technical efficiency involves either reducing inputs for a specific level of outputs or increasing outputs for a specific level of inputs. Second, we provide up-to-date information and data on the key characteristics and the evolution of the second pillar in Greece.

The objective of the paper is to promote a better understanding of the functioning of occupational pension funds in Greece by assessing their efficiency. The research hypothesis is related to whether Greek occupational pension funds are technically efficient and what factors contribute to variations in their performance.

The paper is organized as follows: Sect. 2 provides possible explanations for the underdevelopment of Greek occupational pension funds. Section 3 focuses on the reasons that render funded pension schemes in Greece a necessity. Section 4 presents the main (institutional and operational) features and analyses the development path and performance of the Greek occupational pension sector. Section 5 focuses on describing the data set, the used variables, and methodology, while the next section presents and explains the empirical results. Conclusions and the policy implications of the results are provided in Sect. 7.

2 The three-pillar system in Greece and the limited role of funded pension schemes

Are all pillars in Greece sufficiently developed to enhance multi-pillared pension system efficiency and adequacy of future pension benefits? According to the Hellenic Union of Institutions for Occupational Retirement Provision (HUIORP) in 2020 public expenditure for statutory primary and auxiliary pensions (pillar I) equaled €28,7 billion, investments of the voluntary third pillar reached €15,9 billion (Hellenic Association of Insurance Companies 2020), whereas occupational pension amounted only to €1,7 billion.

After the Greek bailout and during the Greek Economic Adjustment Programs over the period 2010–2018,[2] pension expenditures stemming from the general budget were decreased and put in a plan to decline further as a percentage of GDP over the next several years (see, for example, pension reforms Law 3865

[2] Considering Greece's financial difficulties, these three programs provided loans to Greece conditional on the implementation of policy measures.

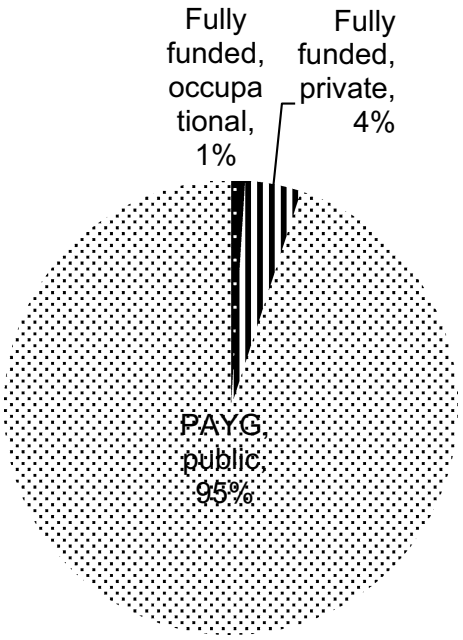

Fig. 1 Annual payments for contributions to pensions per pillar in Greece (as % of total contributions), 2018. *Source*: Pissarides et al. (2020)

(Government Official Journal 2010), Law 4387 (Government Official Journal 2016), and Law 4472 (Government Official Journal 2017). Robolis and Betsis (2016) estimate that the austerity policies of internal devaluation generate a 40% average reduction in public pensions. Nevertheless, what has not changed during these programs is that the current Greek pension system essentially remains almost exclusively as PAYG failing to advance toward a multi-pillar system. According to Pissarides et al. (2020), payments for contributions to funded pensions (occupational and private) were only 5% of the total contributions in 2018 (Fig. 1), while the relevant OECD average was about 50% (OECD 2019).

Figure 2 shows that the lowest percentage of total assets in funded and private pension arrangements in GDP (0.036% in 2011 and 1.006% in 2021) was in Greece (OECD 2018b). Therefore, Greece is significantly behind other advanced countries and the current Greek pension system is hardly favorable to the greatest possible dispersion of economic and demographic risks.

But, why have occupational schemes not been sufficiently developed in Greece? There are various possible reasons for the underdevelopment of these schemes and thus for the suboptimal effects of a three-pillar system. For instance, the value of pension benefits paid from the mandatory part of the pension system is one of the most frequently mentioned in the literature (e.g., Feldstein 1980; Lehmann-Hasemeyer and Streb 2016). The Bismarckian pension schemes—and contrary to Beveridgean ones—largely crowd out any significant role for occupational pension schemes (Ebbinghaus 2011). Greece is a typical example since the Greek pension system was too generous and allowed for numerous options for early retirement. Greek replacement rate, that is, the size of pensions relative to the working-age

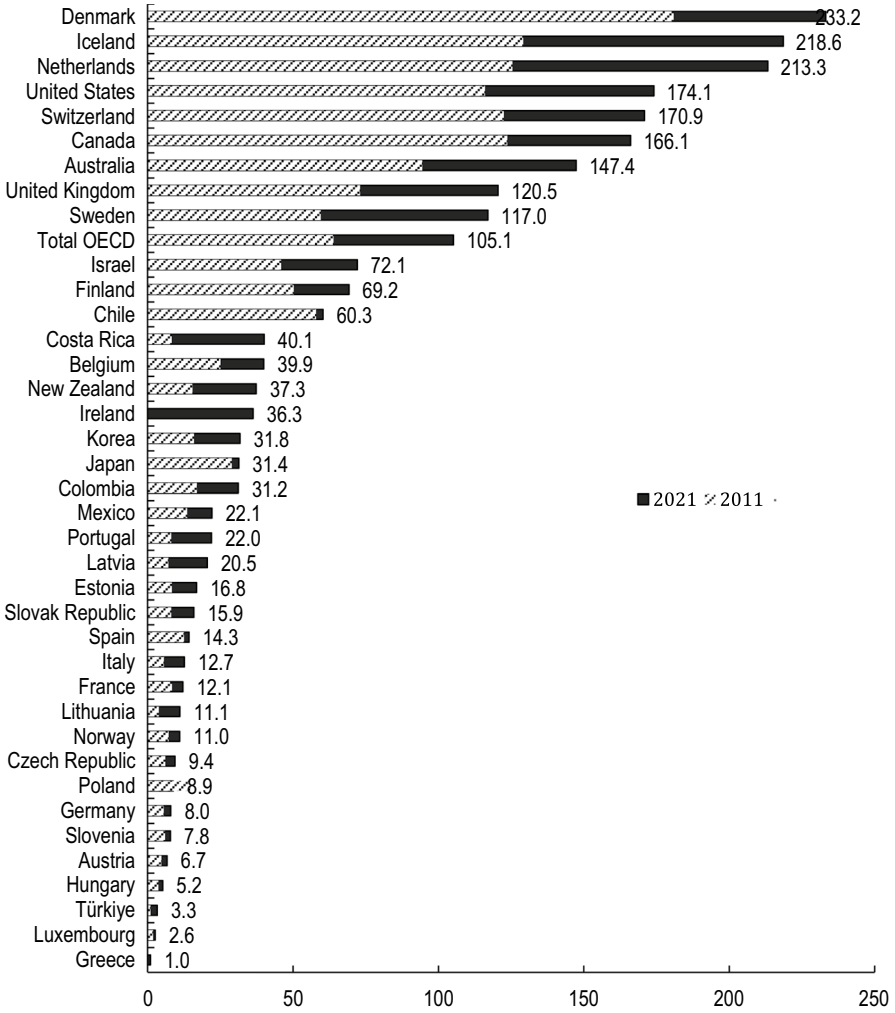

Fig. 2 Total assets in funded and private pension arrangements (as % of GDP), in 2011 and 2021. *Source*: OECD (2022)

incomes, from mandatory pensions approached or even exceeded 100%. This was the highest score across all earnings levels and among OECD countries before the debt crisis (OECD 2013). The higher the level of public social security, the fewer people decide to accumulate private savings. Second, the level of financial literacy that would encourage higher allocations to the second pillar was not sufficient as Greek households make very limited use of financial instruments (Finance and Network 2020). Furthermore, serious financial difficulties during the Greek crisis and the adverse tax treatment of the privately funded pension schemes have contributed to the limited development of the second pillar (Pissarides et al. 2020). Fourth, occupational pensions in south-eastern European countries are limited due to their

'mixed market economies', a type of governance characterized by a limited role for markets (Ebbinghaus 2015). In the case of Greece, the outcome of the various Greek pension reforms in the past has been dependent on the nature of political competition and organized labor preferences (Romanias 2007; Carrera et al. 2010).

Sixth, the voluntary character of these schemes until 2013 in conjunction with the lack of the investment of the state (as an employer) in occupational pensions for public employees had an adverse impact on the establishment of the second pillar. Compulsion generally leads to higher coverage and significant growth of assets as a proportion of GDP (OECD 2018b).

3 Funded pension schemes in Greece: a necessity

The importance of enhancing funded pension schemes, for example, occupational, in Greece is based on multiple reasons. We can identify three main arguments. The first concerns the emergence of favorable conditions for funded schemes as circumstances have changed. Quite a few of the aforementioned reasons for the restricted development of the second pillar no longer exist, while various problems related to the Greek pension system render the decisive shift towards funded pensions a necessity. In recent years there has been a historical shift in the political economy of the Greek pension reforms; a shift from 'social insurance' and thus the security of income to 'social security' that is based on a unified treatment (on behalf of the state) of the insured persons against various risks.[3] The resulting reduction in replacement rates requires supplementary insurance based on professional diversification and the nature of employment (HUIORP June 2019). Furthermore, in response to negative demographic trends and to guarantee adequate pensions for future retirees, a new Law, (Law 4826, Government Official Journal 2002) envisages the transition of public auxiliary pensions from a non-financial defined contribution (NDC) scheme to a fully funded defined contribution (DC) scheme, financed by mandatory social pension contributions paid by all employed persons. This new auxiliary fund, the 'Hellenic Auxiliary Pensions Defined Contribution Fund' (TEKA) is in line with Pissarides et al. (2020) recommendations for systems that will further align benefits with contributions, thereby providing incentives for labor force participation. Moreover, the Directive EU (2016)/2341 that reshapes the occupational pensions industry was transported into Greek law in 2019. Institutions for occupational retirement provision (IORPs) must invest according to prudent person principles, improve their internal risk management functions, and make more data and information available to members and beneficiaries to protect their entitlements.

Various problems related to the Greek pension system and budget problems render the shift towards funded pensions, that is, occupational, a necessity. First, a separate category is the fiscal strain associated with the Greek pension system deficiency. The pension system and its problems were at the core of the

[3] This was the result of the consolidation of all PAYG pension funds into EFKA achieving administrative and operational unification (Law 4387/2016).

bankruptcy of the Greek economy in 2009 and the successive deep and long recession (Lyberaki and Tinios 2012; Giannitsis 2016). According to Giannitsis (2016), 83.6% of the increase of the national debt is due to the grants to the pension system for the period 2001–2009, while 35.8% of the increase in the public sector deficit corresponded to central government expenditures on pensions between 2006 and 2009. Greece also came top for the relative generosity of its pensions through the decades, while this system had the worst performance in old-age poverty alleviation (Panageas and Tinios 2017). Even though successive pension reforms during the crisis restricted public pension expenditures through the years Greece spent on public pensions 15.5% of GDP in 2017 (OECD 2021). This performance represents one of the largest proportions among OECD countries (OECD 2020, 2021). Greece's public pension spending is expected to decline to 12.5% in 2050 but remains higher than the relevant average value of OECD-EU countries, that is, 11% (OECD 2020). All in all, the pension system relies exclusively on redistributive pension schemes (PAYG); schemes that continue to be under tremendous pressure. Second, the main driver of growing pension expenditures is demographic change. The working-age population in Greece is projected to shrink by at least one-third by 2060 (OECD 2021). Based on the old-age to working-age ratio (OECD 2021), Greece is one of the oldest countries as this indicator is expected to reach more than 75 (meaning 75 individuals aged 65 and over for 100 persons of working age defined as 20 to 64) by 2050, whereas the average value for OECD countries is expected to reach the value of 52.7. These adverse demographic changes are exerting tremendous pressure on the Greek PAYG pillar. In line with EU recommendations for enhancing occupational pensions as an antidote to the demographic developments in the EU and the situation regarding national budgets (EU Directive 2003/41/EC and 2016/2341), Pissarides et al. (2020) and Symeonidis et al. (2021), among others, suggest that the promotion of funded components in pension systems is a large part of the solution to these demographic pressures.

Besides pension system problems, budget problems, and the above-mentioned new favorable conditions, significant economic developments are associated with the development and the deepening of the funded pension schemes (e.g., OECD 2018a). As institutional investors in the domestic economy—that is, collect and invest the money contributed by the employer or the employee—pension funds contribute to capital markets deepening (e.g., Babalos and Stavroyiannis 2020). Countries with larger pre-funded pensions have larger capital markets, larger firms with more dispersed ownership, and larger financial sectors (Scharfstein 2018). Moreover, funded pensions stimulate economic growth (i.e., World Bank 1994, and for empirical support see Davis and Hu 2008 for a panel of 38 countries both OECD and Emerging Market Economies (EME)), improve consumption smoothing (OECD 2016, 2018a), and create jobs (for a review, see Thomas and Spataro 2016). According to OECD (2018b), a pension system that combines PAYG and funded arrangements is more likely to achieve its various objectives and mitigate the multiple risks to old-age financial security.

In the case of Greece, FEIR (2022) stresses the potential contribution of the Greek occupational pension sector toward easing macroeconomic imbalances by

narrowing the savings and investment gaps. Using macroeconomic simulations, this study argues that in the long run, the occupational pension sector will be able to generate capital reserves greater than 10% of the GDP and increase economic output by €2,7 billion per year. Other studies highlight the importance and the efficiency of the funded pensions in Greece. Symeonidis et al. (2021) show that the introduction of mandatory funded components in the Greek pension system is expected to increase the replacement rates at retirement; therefore, reducing the fiscal burden for the state and addressing the chronic private savings deficit of the Greek economy. Nektarios and Tinios (2019) maintain that funded private pensions can be a valuable tool for reallocating national savings toward long-term investment in a country where growth is impeded by a considerable shortage of savings, for example, Greece. Milonas et al. (2009) by utilizing data on pensions' reserves from 1950 to 2000 showed that efficient management of reserves could have resulted in additional significant revenues with certainty.

4 Overview of the Greek occupational pension funds: an upward trend

The first attempt—a rather hesitant[4] attempt compared to the ones adopted in other EU states (Sotiropoulos 2004; Romanias 2007)—to bring the mono(public)-pillar Greek pension system closer to a multi-pillar one through the development of a second funded pillar took place in 2002. More explicitly, Law 3029 (Government Official Journal 2002) established voluntary occupational pension schemes as private legal entities of private law of non-profit character only for the employees of the private sector. Since then, their operation and management were additionally regulated by the Code of Conduct and Good Practices for Occupational Pension Funds including risk management, internal audit, actuarial function, financial and accounting infrastructure, management structure, operating regulations, transparency, etc., and supplementary laws, for example, the Law 4680 (Government Official Journal 2002), by way of which the EU Directive 2016/2341 (IORP II) was transposed into Greek legislation.[5] Voluntary occupational pension funds aim at providing additional occupational insurance protection, beyond the compulsory social insurance, against several insurance risks, such as old age, death, occupational accident, disability, illness, layoff, etc. Table 1 reports the key characteristics of the Greek voluntary occupational pension funds.

Yet, occupational pension funds operate either on a voluntary or a mandatory basis. Compulsory ones were founded in 2013 by Law 4052 (Government Official Journal 2012). This Law permitted the transformation of the ex-public legal entities

[4] The introduction of funded schemes was only on paper. Auxiliary funds of the pillar I (PAYG) have not been gradually transformed into funded occupational schemes managed by social partners and the size of the very few schemes established is too limited (Romanias 2007).

[5] IORP II aims to establish a better system for governing occupational pension funds, to increase information transparency for pension savers, and to clarify the procedures for carrying out cross-border transfers and activities.

Table 1 Main characteristics of the Greek voluntary occupational pension funds. *Source*: Hellenic Union of Institutions for Occupational Retirement Provision (HUIORP)

Establishment of an occupational pension fund by a sector, company, or professional organization
Voluntary formation on the initiative of employees or enterprise or by agreement between both ('close' funds)[a]
Non-profit, autonomous, and self-managed legal entities of private law jurisdiction
Operate in line with the funded pension scheme
Defined contribution in nature (the risk is borne by the pension holder)
Supplementary insurance coverage for various risks (e.g., death, accident, disability, illness, and job loss)
Supervision by (1) the National Actuarial Authority, (2) the Ministry of Labour, Social Security, and Social Solidarity, and (3) the Hellenic Capital Market Commission (Government Official Journal 2014)
Mandatory auditing of financial data and statements by certified accountants
Statute regulates their operation
Obligatory website maintenance with updated data (e.g., regulations, actuarial reports, detailed portfolio analysis, budget and expenditures, electronic access to the member's retirement account, investment returns, management fees, etc.)
A four-year Board of Directors consists of members' and employers' representatives as well as third parties

[a]Unlike 'open' pension funds, which can be utilized by anyone residing in a country, 'closed' funds are set up by employers, trade unions, or professional associations of the self-employed exclusively for their employees or members

into compulsory occupational pension funds instead of being merged with ETE-AEP (Supplementary Insurance Fund for Employees in the private sector insured under IKA-ETAM) that unified the numerous auxiliary funds. ETAEP is based on a system of notional defined contribution (NDC) accounts. Compulsory occupational funds operate in substitution for public compulsory supplementary pension schemes. In both cases, the provided benefits could be in kind or in cash that is paid periodically or as a lump sum transfer.

Generally, the Greek occupational pension market is often described as underdeveloped in comparison to other occupational pension markets in the European Economic Area (EAA) countries (Pissarides et al. 2020; FEIR 2022).[6] Greece's average occupational pensions penetration rate for the span 2011–2021 is 0.65% as indicated in Fig. 3. This rate is below the average rate of 16.86% and fairly below the impressive Netherlands rate of 177.02% (Fig. 4).

Despite the aforementioned underdevelopment, there is a systematic upward trend in recent years in terms of the number of newly established funds, the number of occupational pension fund members, the increase in assets, and the return on assets. As shown in Fig. 5, Greek occupational retirement schemes have experienced a significant increase in the number of newly established funds, that is, 156% during 2011–2019, despite the various cyclical financial market crises that marked Southern Europe. This is the best performance among the EEA countries where the

[6] FEIR (2022) analyzes the institution's prospects and challenges and draws important conclusions regarding the positive macroeconomic effect that the development of the second pillar may have on the Greek economy.

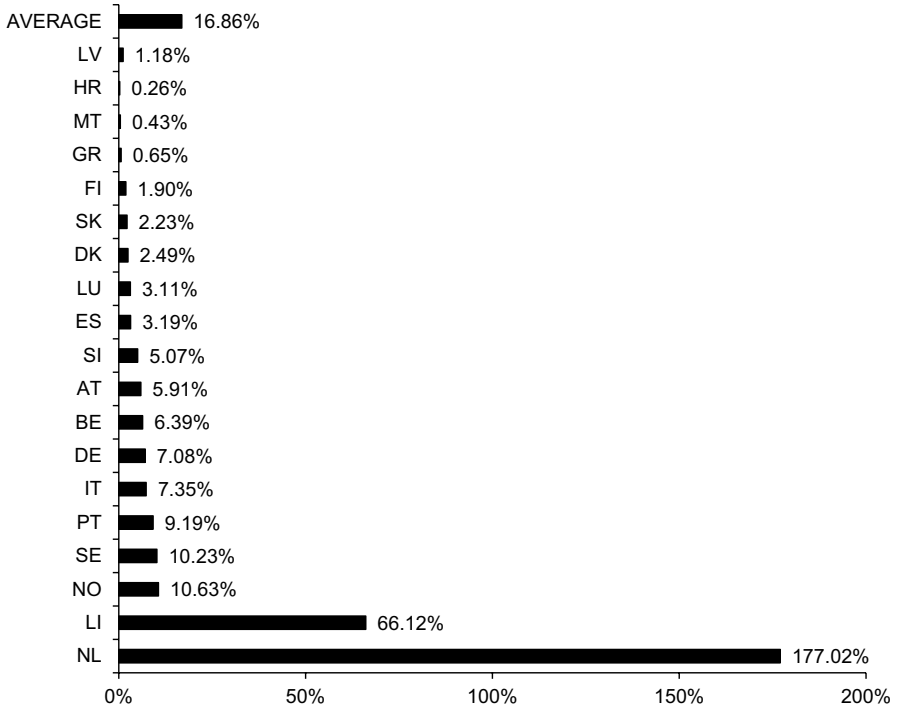

Fig. 3 Average occupational pension funds' penetration rate in selected countries, 2011–2021. Source: Authors' calculations derived from EIOPA (2021a), Bank of Greece (2021 and 2022), Eurostat database (2023), and EIOPA Database (2023)

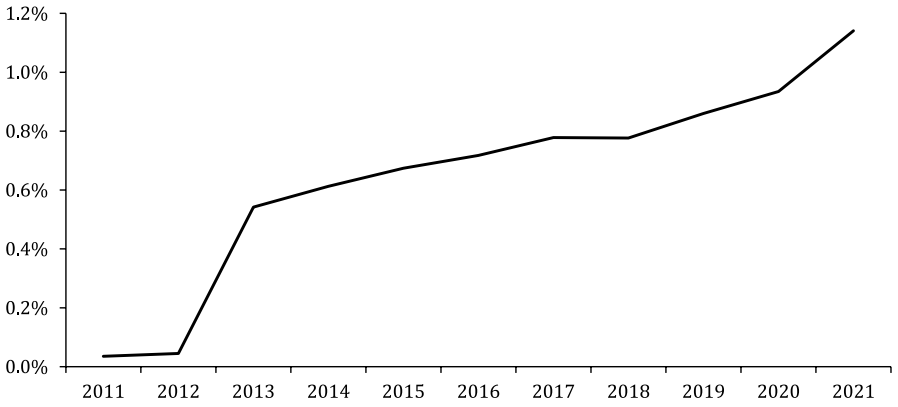

Fig. 4 Greek occupational pension funds' penetration rate, 2011–2021. *Source*: EIOPA (2021a), Bank of Greece (2021 and 2022), and Eurostat database (2023)

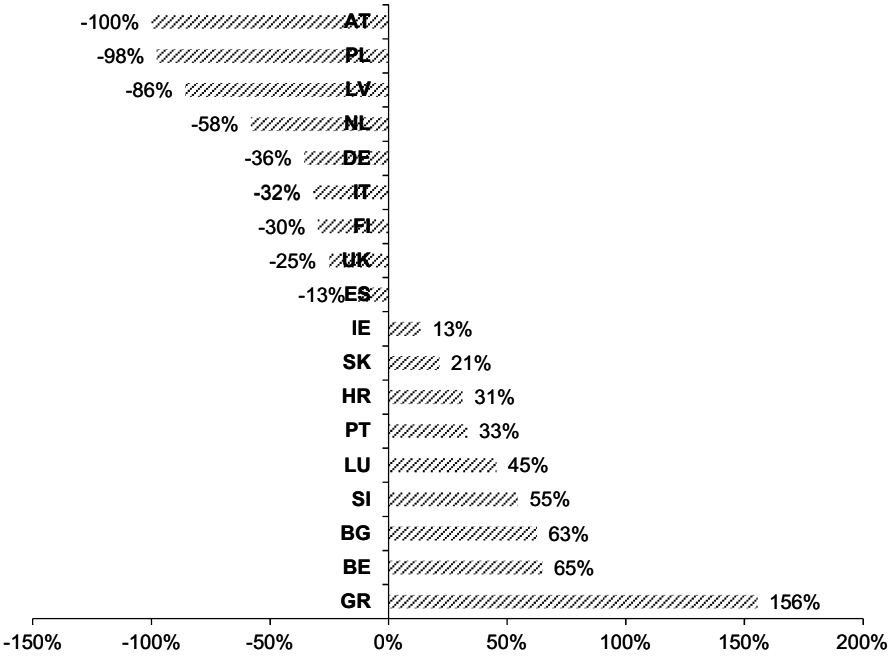

Fig. 5 Percentage change of the number of occupational retirement schemes in selected EEA member countries, 2011–2019. *Source*: Authors' calculations from EIOPA (2021a)

average change is negative and reaches 45% (authors calculations based on European Insurance and Occupational Pensions Authority EIOPA 2021a, b).[7]

Regarding the number of newly established funds, Fig. 6 shows that at the end of 2022, there were 31 close occupational retirement schemes (HUIORP), starting from 4 in 2004: 24 non-compulsory,[8] and 4 compulsory (Appendix).

Table 2 presents the number of occupational pension fund members; active, deferred, and retired. It is worth noting that, a total of 200,000 insured employees in the fourth quarter of 2021 (according to the latest data from HUIORP) indicates a very low level of coverage; 4.32% of the labor force or only 5.16% of the persons employed is saving for retirement in the second pillar (Hellenic Statistical Authority 2021). Among others, this could lead to an increasing problem of low living standards for pensioners in the future, as the Greek first pillar's replacement rate[9] is

[7] There are considerable differences relating to the size, the institutional and operational framework of the national occupational pension fund sectors within the EEA (OECD 2021, for the OECD countries; European Parliament 2014; Curos et al. 2020, for the EU member states). Consequently, a comparative analysis should be made with caution.

[8] It is noteworthy that during the covid19 four new non-compulsory Occupational Insurance Funds have been established.

[9] The replacement rate expresses the average new pension as a share of the average gross wage at retirement.

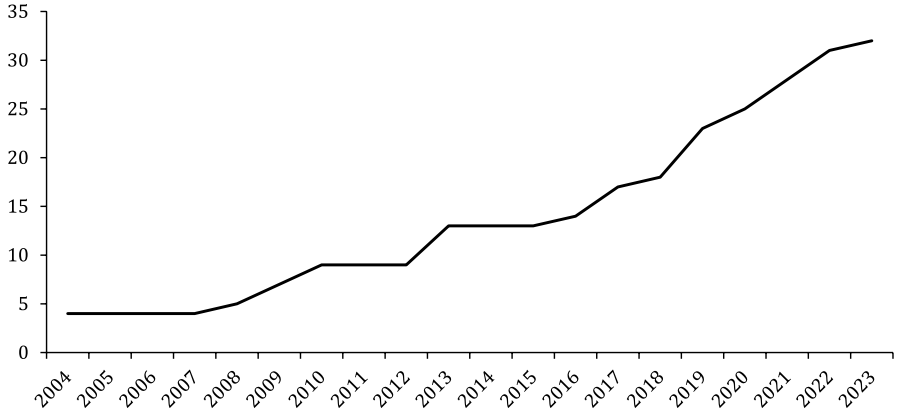

Fig. 6 Number of occupational retirement schemes in Greece, 2011–2023. *Source*: Hellenic Union of Institutions for Occupational Retirement Provision (HUIORP)

expected to decrease from 69% in 2019 to 56.2% in 2070, whereas the average relevant replacement rate between EA countries is 49.3% and 40%, respectively (Economic Policy Committee 2020).

According to the most recent Bank of Greece's published quarterly statistics (Bank of Greece 2021, 2022), total assets of Greek occupational pension funds increased to €1.887,1 million in the fourth quarter of 2022, from €1,136 million in the fourth quarter of 2015, a notable increase of almost 66.12% (Fig. 7).

Undoubtedly, there are major differences among national occupational pension funds in terms of the assets held that are attributed to a variety of factors.[10] For example, according to EIOPA's data for the fourth quarter of 2020 (EIOPA 2021b), the biggest national occupational pension funds sector, in terms of assets held, is the Netherlands with €1,7 trillion, the second biggest is Germany with €238 billion, whereas Croatia has €168 million. The Greek sector has an outstanding performance in terms of the percentage increase of its assets. As indicated in Fig. 8, for the period 2011–2019, Greek occupational pension funds possessed the first place among 24 EEA member countries. The change of total assets of Greek occupational pension funds during 2011–2019 amounted to a staggering 2104%.

The structure of the Greek occupational pension funds asset holdings remained relatively stable between 2019 and 2023 as indicated in Figs. 9 and 10. Geographically, the main assets of Greek occupational pension funds in June 2023—that is, debt securities, mutual funds, and equity—are 51.86% foreign and 48.14% domestic (Fig. 9). Foreign assets are mainly invested in debt securities and fund shares according to Bank of Greece quarterly data (2023). Nevertheless, progress in geographical diversification can be seen, as investments in domestic assets present an upward trend over the last two years. Of domestic assets, the portfolio structure is highly exposed to domestic market risk. The high share of investments in government

[10] Their analysis is beyond the scope of the present analysis.

Table 2 Number of Greek occupational pension funds' members (in '000), 2011–2022. *Source*: EIOPA (2021a) for the years 2011–2018, and Bank of Greece (2023) for the years 2019–2022

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Active Members	15	15	72	79	82	86	92	98	108	112	128	133
Deferred Members	–	–	9	20	23	32	34	45	27	23	31	31
Retired Members	–	–	19	20	21	22	23	24	25	25	27	27
Total Number	15	15	100	118	125	140	150	167	159	161	186	191

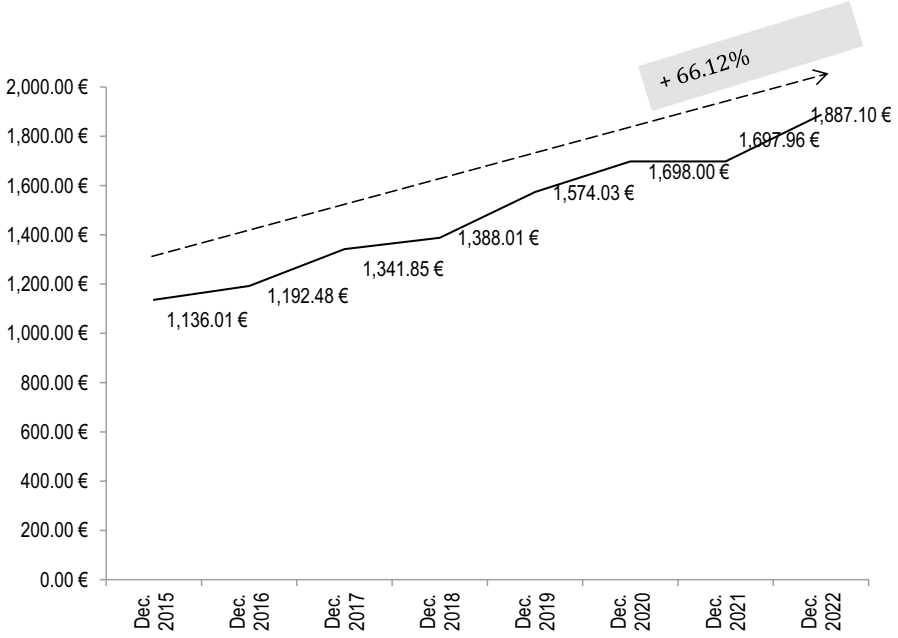

Fig. 7 Total assets of Greek occupational pension funds (in .000), 2015–2021. *Source*: Authors' calculations derived from EIOPA (2021a), Bank of Greece (2021 and 2022), and Eurostat database (2023)

bonds—an average value of 61.22% for the period 2013–2019, (authors' calculations based on EIOPA 2021a)—entails a considerable exposure of the portfolio structure to domestic market risk (high political and country risks).

According to recent data, the Greek second pillar primarily invests in debt securities (48.4%) and mutual funds (30.1%) as illustrated in Fig. 10. Combined, these two instruments account for two-thirds of the sector's balance sheet. Equity and deposits represent a smaller proportion of the sector's investment activity (15.6% and 3.4%

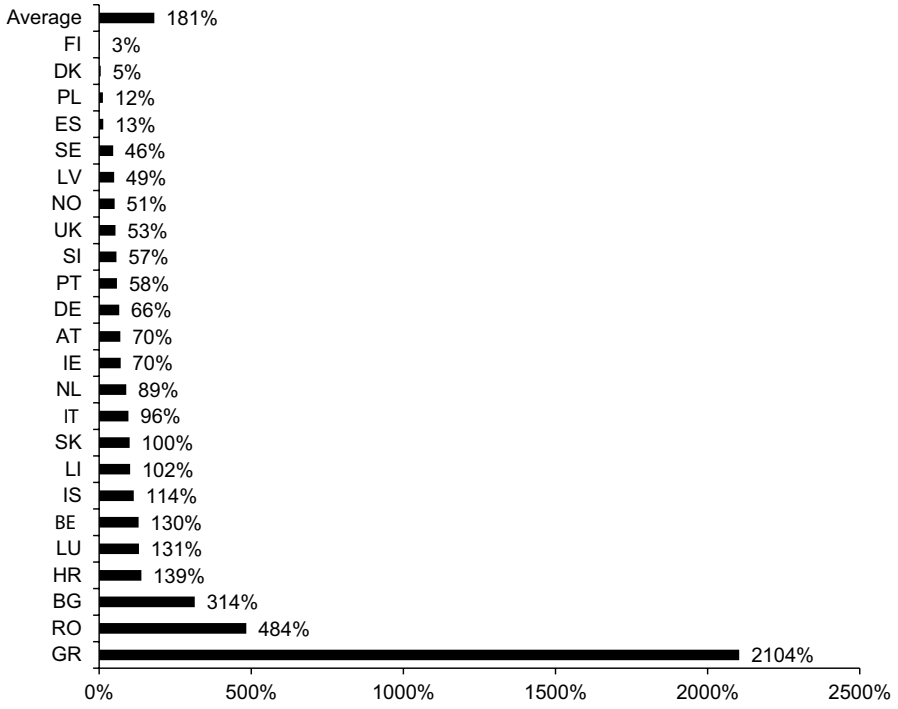

Fig. 8 Percentage change of total assets of occupational pension funds in EAA countries, 2011–2019. *Source*: Authors' calculations from EIOPA (2021a)

respectively). All in all, the asset structure of occupational pensions indicates greater diversification and exposure to risky securities than pillar I.

The main problems and obstacles to the development of occupational pension schemes in Greece are as follows (HUIORP June 2019; FEIR 2022):

- Fragmentation of the surveillance from three independent authorities. This creates further operational costs and considerable retards. There is a need for a single-entry point and simplification of the licensing procedures.
- Absence of an institutional framework for the 'open' or 'multi-employer' occupational pension schemes on behalf of the State, even though EU Directive 2341/2016 allows for such possibility. This possibility permits, among others, the exploitation of economies of scale.
- Discrepancies with international practice as regard to the financial incentives for insured persons and employers (i.e., relatively high VAT liability despite their non-profit character).

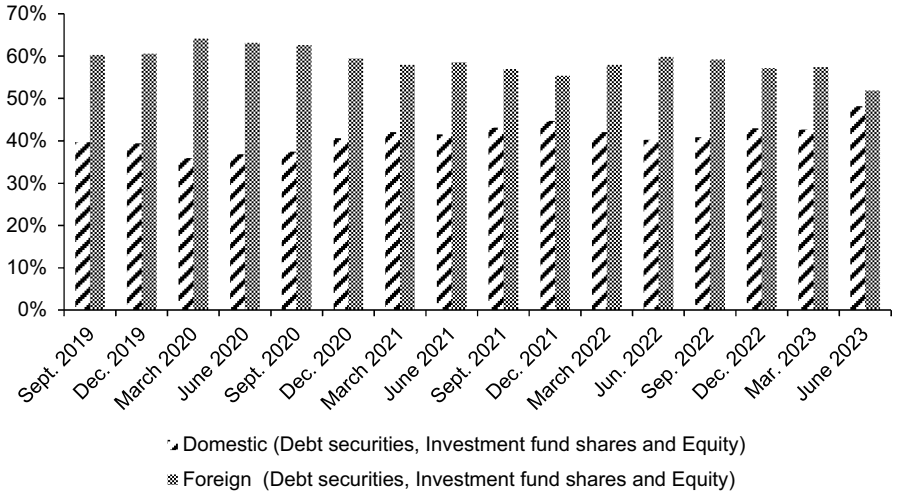

Fig. 9 Geographical asset distribution of Greek occupational pension funds, 2019–2022. *Source*: Bank of Greece (2021, 2022, and 2023)

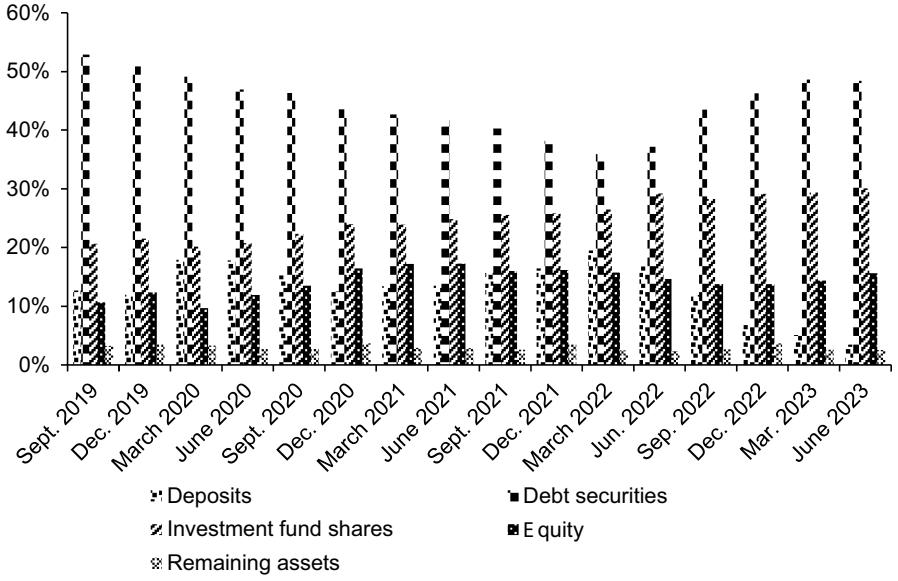

Fig. 10 Asset structure of Greek occupational pension funds, 2019–2023. *Source*: Bank of Greece (2021, 2022, and 2023)

5 Data and methodology

The measurement of efficiency in a business's production function is crucial for making decisions, improving operations, and ensuring overall survival. In this

particular study, the focus is on occupational pension funds in Greece, specifically 28 institutions. However, due to data limitations, only 16 funds were included in the analysis, covering a period of four years from 2017 to 2020. The accuracy of the results obtained through the Data Envelopment Analysis (DEA) relies on the reliability of the data, especially when it involves financial information. Therefore, the final analysis includes the selected 16 occupational pension institutions, referred to as independent decision-making units (DMUs) in the study. The data was collected from the funds' annual financial statements, and since it is secondary in nature, only the audited figures available in the public domain were considered. To adhere to the DEA convention, which recommends a minimum of three times the number of inputs plus outputs as the number of DMUs, the chosen sample size meets this requirement (Raab and Lichty 2002).

In our application of DEA, we utilized balance sheet items as both inputs and outputs. While there are various approaches to measuring efficiency, there is a general consensus on identifying significant inputs and outputs for occupational pension and insurance funds. Previous studies in the literature on DEA applications in the insurance and pension industry (Barros et al. 2005; Garcia 2006; Garcia 2010; Eling 2017; Anandarao et al. 2019; Kaffash et al. 2020) have shown that labor and capital variables are commonly used as inputs. Conversely, variables such as the number of contracts, total contributions, and profit/losses are considered as outputs.

The efficiency of the pension fund sector, in terms of managerial effectiveness, differs from other sectors due to variations in its production function (Gokgoz 2010; Gurol and Imam 2018; Rahman 2018; Almulhim 2019). The efficiency of the pension funds sector relies on the optimal utilization of contributions received and the effective management of operational activities. In this respect, Gokgoz (2010) and Naushad et al. (2020) suggest that the efficiency of insurance companies is connected to converting various types of investments into desired outcomes or objectives.

Selecting appropriate inputs and outputs is a challenging task, particularly for financial firms, and it is crucial for ensuring the validity of the analysis. The essence of the DEA methodology is to identify the optimal combination of inputs that can generate the desired outputs for decision-making units. In the case of financial firms, where outputs are often intangible, determining what they actually produce becomes a key issue. The primary outputs for these firms mainly consist of services (Cummins et al. 2004). Pension fund managers, for instance, utilize capital equipment, employ labor, and make use of marketing services (Barrientos and Boussofiane 2005; Anandarao and Goyari 2019). Additionally, pension fund organizations can be perceived as open systems that utilize inputs (resources) to obtain outputs (converted resources) and distribute these outputs to shareholders (Ali 2016; Gurol and Imam 2018).

The input and output variables employed in this study are presented in Table 3. The application of DEA entails determining and quantifying the pertinent inputs and outputs that are applicable to all units of pension funds. In this particular study, the selected specification includes the following relevant inputs: total assets, total operating expenses, and total equity. As for the relevant outputs, they consist of profits and members' contributions.

Table 3 Description of variables in the DEA model

Variables	Description
Inputs	
Total assets	Total assets in the balance sheet, including insurance premium, property, and others
Total operating expenses	Expenses concern the operation of a pension fund, including executive, administration staff, and mandatory expenses associated with actuarial function, risk management, internal audit, chartered accountants, and trustee and investments managers
Total equity and debt	Including the paid-up capital of the pension fund in addition to the retained earnings after the issuance of both statutory and voluntary reserves and premium on paid-up capital, as well as the value of the change in the investment valuation reserve as at the beginning of the year and finally the long-run debt
Outputs	
Profits	Measures the gross profit minus all other expenses and costs as well as any other income and revenue sources that are not included in gross income
Members' contributions	Revenues from members' contributions

The concept of DEA originated from the influential work by Charnes et al. (1978) and is a non-parametric mathematical programming approach used to construct production frontiers and measure efficiency. This method determines technical efficiency estimators by finding optimal solutions that correspond to these constructed frontiers. In DEA, a piece-wise linear surface is "floated" to align with an observation, as described by Seiford and Thrall (1990). The facets of the hyperplane define the efficiency frontiers, and the level of inefficiency is measured and analyzed using metrics that assess the distances between the observation and the hyperplane and its facets. The efficient combination of input and output lies on the frontier, while inefficient combinations fall below it.

The DEA methodology is based on the efficient ratio of outputs to inputs, where the entities responsible for transforming inputs into outputs are referred to as DMUs. The relative efficiency of each unit is measured to enable comparisons, and the efficiency score is usually standardized between 0 and 1, with the most efficient firm receiving a score of 1 and the least efficient firm receiving a score of 0. The primary objective of DEA is to maximize the Outputs/Inputs ratio for each DMU under consideration (DMUo). This maximization is achieved by optimizing the weights assigned to inputs and outputs, which determine the relative importance of each corresponding input or output.

DEA provides valuable information on three key aspects: (a) the reference set of efficient DMUs for each non-efficient DMU (i.e., the DMUs against which the non-efficient unit is compared), (b) the objectives that non-efficient units should set by adjusting inputs or outputs to optimize their operations, and (c) the returns-to-scale classification for each unit (whether increasing or decreasing).

In this study, the efficiency assessment of the occupational pension sector was conducted using the input-oriented CCR (Charnes-Cooper-Rhodes) and BCC (Banker-Charnes-Cooper) models. The CCR model, which was initially introduced by Charnes

et al. (1978, pp. 429–444), serves as the fundamental model in DEA. This model measures the Global Technical Efficiency and assumes constant returns-to-scale (CRS). The primal non-linear CCR model is presented as follows:

$$\max_{v_i u_r} h_o = \frac{\sum_{r=1}^{s} u_r y_{r_0}}{\sum_{i=1}^{m} v_i x_{i_0}} \tag{1}$$

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \quad \forall\, j = 1, ..., n$$

st.

$$u_r,\ v_i \ \geq \varepsilon$$

$$i = 1, ..., m \quad r = 1, ..., s$$

where h_0: unit's partial productivity, o: the organization under evaluation compare with $j = 1, ..., n$ organizations, j: units, $j = 1, ..., n$, r: outputs, $r = 1, ..., s$, i: inputs, $i = 1, ..., m$, $\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1\ \forall\, j = 1, ..., n$: output r of unit j ($r = 1, ..., s$), x_{ij}: input i of unit j ($i = 1, ..., m$), ε: a very small positive number (i.e. $\varepsilon = 10^{-6}$), u_r, v_i: input and output coefficients, respectively, which maximize the objective function for DMU_o.

Converting the aforementioned equation into a linear problem, whether input or output-oriented, simplifies the solution process. The dual problems associated with the input or output-oriented models provide solutions to the primal problems (Boussofiane et al. 1991, pp. 1–15).

The BCC model, introduced by Banker et al. (1984, pp. 1078–92), provides an assessment of Local Pure Technical Efficiency by considering variable returns-to-scale (VRS), which can be either increasing or decreasing. Assuming the values of a DMU for the CCR and BCC models are θ^*_{CCR} and θ^*_{BCC} respectively, the scale efficiency[11] for a specific DMU can be defined as follows:

$$SE = \frac{\theta^*_{CCR}}{\theta^*_{BCC}} \tag{2}$$

under the condition that $SE \leq 1$. According to the previous ratio, the disaggregation of the efficiency is:

$$\left[\text{Technical Efficiency (TE)}\right] = [\text{Pure Technical Eff. (PTE)}] \times [\text{Scale Eff. (SE)}] \tag{3}$$

The provided breakdown is distinct and highlights the presence of inefficiency, while also indicating whether the inefficiency is attributed to the operation of the DMU itself (Pure Technical Efficiency, PTE), or if it arises from inappropriate

[11] Scale efficiency is described as a company's capability to operate very near to its most productive scale size.

returns-to-scale conditions under which the DMU operates, or potentially from a combination of both factors.

To apply the linear-programming problem, three key aspects of the model need to be specified: the input–output orientation system, the returns-to-scale conditions, and the relative weights assigned in the evaluation system. These weights, determined by the algorithm, reflect the distance between the DMU and the efficiency frontier.

There are two approaches for calculating efficiency indicators: the input-oriented approach and the output-oriented approach. In the input-oriented approach, the goal is to minimize the inputs required for a constant level of production. Conversely, the output-oriented approach aims to maximize the production level while keeping the inputs constant. The choice between these approaches depends on the market conditions of the DMU. In competitive markets, DMUs are generally expected to be output-oriented, focusing on maximizing output based on demand by controlling their inputs. On the other hand, in monopolistic markets, DMUs tend to be input-oriented as the output is endogenous and the input is exogenous, making the cost function a natural choice (Barros and Garcia 2006; Wanke and Barros 2016).

Returns-to-scale can be either constant or variable, and both forms (the CCR and BCC models) are calculated for comparison purposes (Eling and Luhnen 2010). In this research, the efficiency of occupational pension funds is evaluated based on the optimization of input utilization to generate outputs within a specific timeframe, adopting an input-oriented technical efficiency approach. The focus is on the "management" aspect of occupational pension funds, specifically how efficiently a fund utilizes managerial resources to generate revenues and profits.

6 Analysis of efficiency: occupational pension schemes in Greece

Table 4 presents the frequency distribution of technical efficiency scores based on the constant returns to scale (CRS) assumption using the input-oriented model from 2017 to 2020. The input-oriented model emphasizes the extent to which inputs can be proportionally reduced while keeping outputs fixed. The efficiency scores range from 0 to 1, with a score of 1 indicating that the DMU is operating at the frontier.

Table 4 presents significant variations in the levels of technical efficiency observed among the occupational pension schemes. In 2017, the technical efficiency scores ranged from 0.207 (lowest) to 1.000 (fully efficient institutions). According to the DEA model, 8 out of 16 pension funds (50% of the sample) achieved full technical efficiency. Six institutions (37.50%) had technical efficiency scores below 60%, while one institution (6.25%) fell within the 60–79% range, and another institution (6.25%) operated near the DEA frontier with a technical efficiency score between 80 and 99%. Similarly, in 2018, the technical efficiency scores ranged from 0.315 to 1.000. Eight pension funds (50% of the sample) achieved full technical efficiency, while five funds (31.25%) had scores below 60%. One fund (6.25%) fell within the 60–79% range, and two funds (12.50%) operated near the DEA frontier with scores between 80 and 99%. In 2019, the technical efficiency scores ranged from 0.198 to 1.000. Six occupational pension funds (37.50% of the sample) achieved

Table 4 Frequency distribution of technical efficiency estimate, CRS, 2017–2020. *Source*: Authors' calculations

	2017		2018		2019		2020	
TE score	Number of institutions	% Of institutions	Number of institutions	% Of institutions	Number of institutions	% Of institutions	Number of institutions	% Of institutions
<0.60	6	37.50	5	31.25	4	25.00	5	31.25
0.60–0.80	1	6.25	1	6.25	4	25.00	2	12.50
0.80–1.00	1	6.25	2	12.50	2	12.50	1	6.25
=1.00	8	50.00	8	50.00	6	37.50	8	50.00
Total	16	100.00	16	100.00	16	100.00	16	100.00

full technical efficiency, while four funds (25%) had scores below 60%. Four funds (25%) fell within the 60–79% range, and two institutions (12.50%) operated near the DEA frontier with scores between 80 and 99%. In 2020, the technical efficiency scores ranged from 0.2795 to 1.000. Again, eight institutions (50% of the sample) achieved full technical efficiency, while five funds (31.50%) had scores below 60%. Two funds (12.50%) fell within the 60–79% range, and one fund (6.25%) operated near the DEA frontier with a score between 80 and 99%. Overall, an upward trend in managerial efficiency is evident, with six pension funds consistently demonstrating efficiency throughout the study period. Additionally, a few institutions have maintained relatively high levels of efficiency over the years.

The findings also highlight that a significant percentage, ranging from 48 to 50%, of the pension funds achieved the highest level of technical efficiency from 2017 to 2020. This indicates a low level of inefficiency in the operations of the sector and suggests that many pension funds effectively utilized the available technology in their management practices. However, the presence of technical inefficiency in a few institutions suggests that their management was inadequate in effectively utilizing the entrepreneurial factor, which can greatly impact the economic performance of a pension fund. Inefficient pension funds are indicative of poor management skills and a failure to achieve the optimal balance between inputs and outputs. Moreover, it is worth noting that pension funds often have diversified portfolios without adequate emphasis on insurance and pensions. This can result in increased expenses and a lack of proportionality between premiums and investment income in relation to the inputs used. This imbalance may contribute to inefficiencies within the system.

Table 5 displays the average technical efficiency scores based on the DEA-VRS (Variable Returns to Scale) model from 2017 to 2020. A score of 1 indicates that the DMU is operating at the efficiency frontier. The first column represents the 16 pension funds in Greece, while the second column shows the technical efficiency (CRS) index results. Among these funds, eight occupational pension funds achieved a perfect efficiency score of 1, indicating they operate at 100% relative efficiency compared to the overall sample. The third column illustrates the pure technical efficiency (VRS) index results, where a larger number of occupational pension funds (10) achieved 100% relative efficiency in transforming their inputs to outputs compared to the overall sample. The fourth column represents the scale efficiency of the DMUs, indicating whether they were operating at an optimal size given their specific input–output mix. The findings indicate that eight pension funds achieved 100% scale efficiency, suggesting that scale economies are the primary source of inefficiency in pension funds.

The average technical efficiency for the 16 institutions from 2017 to 2020 is calculated to be 0.73, while the variable technical efficiency is determined to be 0.836. These results suggest that the average Greek occupational pension fund's efficiency could be improved by at least 27%. However, when considering variable returns-to-scale, the potential for improvement decreases to 16.4%. It is worth noting that all technically efficient CRS occupational pension funds, indicated by efficiency scores of 1, are also technically efficient in VRS as their VRS scores are also 1. This indicates that the dominant source of efficiency is scale. It is observed that occupational pension funds with decreasing returns to scale (DRS) are relatively larger in size,

Table 5 Average technical efficiency scores per institution, VRS, 2017–2020. *Source*: Authors' calculations

Occupational pension schemes	Technical efficiency, constant returns-to-scale (CCR)	Technical efficiency, variable returns-to-scale (BCC)	Technical efficiency scale	Returns-to-scale
DMU1	0.559	1.000	0.559	IRS
DMU2	0.224	0.552	0.405	IRS
DMU3	0.556	1.000	0.556	IRS
DMU4	0.371	0.443	0.839	IRS
DMU5	1.000	1.000	1.000	CRS
DMU6	0.207	0.228	0.909	DRS
DMU7	0.526	0.554	0.951	IRS
DMU8	1.000	1.000	1.000	CRS
DMU9	1.000	1.000	1.000	CRS
DMU10	0.713	0.799	0.892	DRS
DMU11	1.000	1.000	1.000	CRS
DMU12	0.519	0.808	0.643	IRS
DMU13	1.000	1.000	1.000	CRS
DMU14	1.000	1.000	1.000	CRS
DMU15	1.000	1.000	1.000	CRS
DMU16	1.000	1.000	1.000	CRS
Mean	0.730	0.836	0.860	

whereas those with increasing returns to scale (IRS) are relatively smaller in size. Thus, the overall conclusion is that Greek occupational pension funds exhibit average-quality management in terms of pure technical efficiency.

By employing DEA, the analysis reveals the inefficiencies of certain DMUs and provides a reference set or peer group for each inefficient DMU, offering specific recommendations to enhance efficiency (as shown in Tables 6 and 7). In the period from 2017 to 2020, eight pension funds were identified as technically efficient (as displayed in Table 5). These efficient funds collectively establish the best practice or efficient frontier and serve as the reference set for the inefficient ones. These occupational pension funds exhibit effective resource utilization, indicating that they operate without any wastage of inputs. In DEA terminology, these efficient pension funds are considered peers, setting a benchmark for the inefficient ones to follow in terms of operational practices. For the period from 2017 to 2020, the efficient Greek occupational pension funds include DMU1, DMU3, DMU5, DMU11, DMU13, DMU14, DMU15, and DMU16. The remaining occupational pension funds have technical efficiency scores below 1, indicating their inefficiency. Consequently, the results indicate significant deviations of these funds from the best practice frontier. For instance, pension fund 4 serves as a reference or peer for pension funds 3, 14, 5, and 16.

Table 6 Peers, 2017–2020. *Source*: Authors' calculations

Occupational pension schemes	Peers.peer1	Peers. peer2	Peers.peer3	Peers.peer4
DMU1	DMU1			
DMU2	DMU5	DMU3		
DMU3	DMU3			
DMU4	DMU3	DMU14	DMU5	DMU16
DMU5	DMU5			
DMU6	DMU13	DMU14	DMU16	
DMU7	DMU16	DMU5	DMU11	DMU3
DMU8	DMU8			
DMU9	DMU9			
DMU10	DMU11	DMU14	DMU13	
DMU11	DMU11			
DMU12	DMU16	DMU1		
DMU13	DMU13			
DMU14	DMU14			
DMU15	DMU15			
DMU16	DMU16			

The sources of inefficiency in occupational pension funds can be attributed to either improper utilization of inputs or the inability of these inputs to generate the desired level of output. Consequently, if these funds optimize their input usage while maintaining the same level of output, they can enhance their efficiency and achieve full technical efficiency. Table 7 provides insight into the necessary reduction in inputs (slacks) that each pension fund must undertake to achieve full efficiency. As an example, pension fund 4 would need to reduce its operational expenses by €41,325.6 and its total equity and debt by €156,437.98 in order to become efficient (as indicated in Table 7). Upon examining the ratios for each occupational pension fund, it becomes evident that total equity and debt are the most significant determinants of pension fund efficiency, followed by total assets. On the other hand, operating expenses are found to be the least influential factors affecting efficiency.

7 Discussion and conclusion

There is a necessity to further enhance and broaden the ongoing conversations and deliberations regarding the future of Greek "saving vehicles," particularly occupational pension institutions. The IORP II directive emphasizes the importance of enhancing "complementary private retirement savings" such as occupational pension schemes, particularly as social security systems face growing challenges. The

Table 7 Input slacks, 2017–2020. *Source*: Authors' calculations

	Input Slacks		
Occupational pension schemes	Total assets	Total operating expenses	Total equity and debt
DMU1	€0.00	€0.00	€0.00
DMU2	€31,753.00	€0.00	€238,545.19
DMU3	€0.00	€41,325.6	€156,437.98
DMU4	€0.00	€0.00	€196,587.60
DMU5	€0.00	€0.00	€0.00
DMU6	€613,538.32	€0.00	€5,163,446.71
DMU7	€0.00	€0.00	€2,462,511.21
DMU8	€0.00	€0.00	€6,258,060.78
DMU9	€197,181.13	€0.00	€0.00
DMU10	€0.00	€0.00	€1,193,584.45
DMU11	€0.00	€0.00	€0.00
DMU12	€0.00	€0.00	€67,309.951
DMU13	€0.00	€0.00	€0.00
DMU14	€0.00	€0.00	€0.00
DMU15	€0.00	€0.00	€0.00
DMU16	€0.00	€0.00	€0.00

directive also emphasizes that member states should mandate occupational pension schemes to establish a robust system of governance that ensures responsible and prudent management of their operations.

In this particular context, this research brings a novel approach by assessing the performance of Greek occupational pension schemes, which has never been done before. The study focuses on evaluating the technical efficiency of these schemes and identifying their key determinants from 2017 to 2020, utilizing an input-oriented DEA model. The findings reveal that approximately 45–50% of the occupational pension funds achieved the highest level of technical efficiency during the mentioned period. This indicates that around half of the pension funds managed their existing resources efficiently in terms of administration, while there is potential for improvement in output for about 50–55% of the funds without the need for additional input resources. Moreover, the study observes a gradual improvement in technical efficiency for Greek occupational pension funds over the study period. Among the internal factors influencing the efficiency of these funds, total equity and debt play a significant role, followed by total assets and operating expenses. Additionally, it is worth noting that the scale efficiency of occupational pension funds is not uniform, implying that the efficient performance of small pension funds is constrained by their size.

These findings have significant implications for both occupational pension scheme managers and policymakers, making them highly valuable. The study highlights areas where improvements can be made, offering valuable insights. The researchers recommend several strategies to enhance the technical efficiency

of low-performing occupational pension funds. These include reducing input levels, reallocating resources to maximize efficiency, and enhancing managerial skills to achieve optimal efficiency. According to the VRS model, pension funds that appear to be technically inefficient should focus on organizational factors such as marketing initiatives, quality improvement, and achieving a better balance between inputs and outputs. Furthermore, policymakers and regulators are increasingly recognizing the importance of having efficient "saving vehicles" in place. It is no longer just a preference but a necessity. Given that scale efficiency appears to be the primary driver of efficiency, policymakers should explore measures to promote the consolidation of pension funds. For instance, they could consider allowing the establishment of "open" or "multi-employer" pension funds, as suggested by Mitchell and Andrews (1981). These measures can help improve the overall efficiency and effectiveness of occupational pension schemes.

The study's limitations encompass the omission of findings derived from Tobit regression analyses, which commonly involve examining the impact of factors like GDP, education level, family size, and non-pension social security measures on the technical efficiency score. While conducting such an analysis could enrich the substance of our policy recommendations, we have chosen to present solely the pertinent findings directly associated with policy analysis due to space constraints within the paper. Furthermore, the possibility of integrating cost efficiency and allocative efficiency assessments with technical efficiency remains an avenue for potential future research.

As a final note, we may suggest some areas for further research. Firstly, in the literature on occupational pension funds, the Southern European situation has been relatively neglected compared to occurrences in Continental, Anglo-Saxon, and Nordic nations (due to factors such as political economy considerations in these countries). Therefore, it would be interesting to explore how the findings extend beyond Greece in a comparative and cross-policy study focusing on the efficiency of occupational pension funds in Southern Europe. Particularly, assessing the efficiency of occupational pensions in fiscally troubled Eurozone countries with a focus on the PIIGS (Portugal, Italy, Ireland, Greece, and Spain) would be a fruitful area for further work. Secondly, additional research could usefully evaluate the total productivity of Greek pension funds using the Malmquist Index. This index provides a means to analyze shifts in productivity, breaking them down into changes in technical efficiency (including pure technical and scale efficiency) and technological change.

Appendix

See Table 8.

Table 8 Greek occupational insurance funds

a. Compulsory occupational insurance funds
Occupational Insurance Fund of Insurers and Personnel of Insurers Companies
Occupational Insurance Fund of Pharmaceutical Employees
Occupational Pension Fund for Employees of Food Commerce
Occupational Supplementary Pension Fund of Personnel of Petrochemical Companies
b. Non-Compulsory occupational insurance funds
Occupational Insurance Fund of the Ministry Of Finance
Occupational Insurance Fund for Economists
Occupational Insurance Fund of the Hellenic Post
Occupational Insurance Fund of Geotechnical Chamber Members
Occupational Insurance Fund of Casino Employees
Occupational Insurance Fund of Air Traffic Controllers of Greece—O.I.F.A.T.C.G
Occupational Insurance Fund of Hellenic Section of International Police Association
Occupational Insurance Fund of Johnson & Johnson, Johnson & Johnson Consumer and Janssen—Cilag Employees
Occupational Pension Fund of the Personnel of Interamerican
Occupational Pension Fund of the Institute of Certified Public Accountants of Greece
Occupational Insurance Fund P.A.S.I.A.L. & E.A.—Private Legal Entity
Occupational Pension Fund of the Medical Chamber of Thessaloniki
Occupational Pension Fund of Tsakos Maritime Enterprises & Associates
Accenture's Personnel Institution for Occupational Retirement, Life and Medical Provision
Occupational Pension Fund of Hellenic Civil Aviation Authority
Interamerican Insurance Intermediaries Occupational Pension Fund
Occupational Pension Fund of Interlife AAEGA
Occupational Pension Fund of Beta CAE Systems SA
Occupational Insurance Fund of Athens Exchange Group Employees
Occupational Pension Fund of the Hellenic Fund and Asset Management Association—Private legal Entity
Piraeus Bank's Group Personnel Institution for Occupational Retirement, Life and Medical Provision
Occupational Pension Fund of Intrum Hellas A.E.D.A.D.P
Institution for Occupational Retirement Provision of Athens International Airport S.A. Personnel
Institution for Occupational Retirement Provision of Eurolife FFH Group
IORP Eurobank's Group Personnel
Institution for Occupational retirement provision for employees and associates of Dynamis and Genka
Eurobank's Group Personnel Institution for Occupational Retirement, Life and Medical Provision
Pension Fund Members and Employees of Athens Medical Association

Acknowledgements The authors wish to thank Nikos Mylonidis, Christos Giannakoulas, and Michael Yates for helpful comments and suggestions.

Declarations

Conflict of interest The authors did not receive support from any organization for the submitted work. The authors have no relevant financial or non-financial interests to disclose.

References

References in the English language

Ali AS (2016) Efficiency of private pension companies in turkey using data envelopment analysis (DEA). In: Chaos, complexity and leadership 2014. Springer, pp 495–505. https://doi.org/10.1007/978-3-319-18693-1_45

Almulhim T (2019) Analysis of takaful vs. conventional insurance firms' efficiency: two-stage DEA of Saudi Arabia's insurance market. Cogent Bus Manag 6(1):1633807. https://doi.org/10.1080/23311975.2019.1633807

Anandarao S, Durai S, Goyari P (2019) Efficiency decomposition in two-stage data envelopment analysis: an application to life insurance companies in India. J Quant Econ 17(2):271–285. https://doi.org/10.1007/s40953-018-0148-1

Babalos V, Stavroyiannis S (2020) Pension funds and stock market development in OECD countries: novel evidence from a panel VAR. Financ Res Lett 34:101247. https://doi.org/10.1016/j.frl.2019.07.020

Bank of Greece (2021) Statistics on Pension Funds: Q3 2021. Athens

Bank of Greece (2022) Statistics on Pension Funds: Q4 2021. Athens

Bank of Greece (2023) Statistics on Pension Funds: Q1 2022. Athens

Banker RD, Charnes A, Cooper WW (1984) Some models for estimating technical and scale inefficiencies in data envelopment analysis. Manag Sci 30(9):1078–1092

Barrientos A, Boussofiane A (2005) How efficient are pension fund managers in Chile? Revista De Econ Contemp 9(2):289–311. https://doi.org/10.1590/S1415-98482005000200003

Barros CP, Garcia MTM (2006) Performance evaluation of pension funds management companies with data envelopment analysis. Risk Manag Insur Rev 9(2):165–188. https://doi.org/10.1111/j.1540-6296.2006.00092.x

Barros CP, Barroso N, Borges MR (2005) Evaluating the efficiency and productivity of insurance companies with a Malmquist index: a case study for Portugal. Geneva Pap Risk Insur Issues Pract 30(2):244–267. https://doi.org/10.1057/palgrave.gpp.2510029

Boussofiane A, Dyson RG, Thanassoulis E (1991) Applied data envelopment analysis. Eur J Oper Res 52(1):1–15. https://doi.org/10.1016/0377-2217(91)90331-O

Carrera LN, Marina A, Carolo DFDS (2010) Political competition and societal veto players: the politics of pension reform in Southern Europe. Rivista Italiana Di Poliche Pubbliche 1:5–31

Charnes A, Cooper WW, Rhodes E (1978) Measuring the efficiency of decision making units. Eur J Oper Res 2(6):429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Christodoulakis N (2018) Sustainability and fairness still missing in the Greek social insurance system. Manag Decis Econ 39(8):897–906. https://doi.org/10.1002/mde.2969

Cummins JD, Rubio-Misas M, Zi H (2004) The effect of organizational structure on efficiency: evidence from the Spanish insurance industry. J Bank Finance 28(12):3113–3150. https://doi.org/10.1016/j.jbankfin.2004.05.004

Curos JG, Herr J, Quevedo R, Valadzija M, Yeh ML (2020) New pension fund statistics. ECB Economic Bulletin 7/2020, European Central Bank, Frankfurt

Davis E, Hu Y (2008) Does funding of pensions stimulate economic growth? J Pension Econ Finance 7(2):221–249. https://doi.org/10.1017/S1474747208003545

Directive (EU) 2003/41/EC of the European Parliament and of the Council of 3 June 2003 on the activities and supervision of institutions for occupational retirement provision, available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32003L0041&qid=1649658765072

Directive (EU) 2016/2341 of the European Parliament and of the Council of 14 December 2016 on the activities and supervision of institutions for occupational retirement provision (IORPs). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016L2341

Ebbinghaus B (2011) The varieties of Pension Governance. Pension privatization in Europe. Oxford University Press, Oxford. https://doi.org/10.1093/acprof:oso/9780199586028.001.0001

Ebbinghaus B (2015) The privatization and marketization of pensions in Europe: a double transformation facing the crisis. Eur Policy Anal 1(1):56–73. https://doi.org/10.18278/epa.1.1.5

EIOPA (2021a) EU/EEA Pension Statistics 2004–2019 Database. https://www.eiopa.europa.eu/tools-and-data/occupational-pensions-statistics_en#Statistics2004-2019
EIOPA (2021b) Financial Stability Report. July 2021, Publications Office of the European Union, Luxembourg
EIOPA Database (2023) Occupational pensions statistics. https://www.eiopa.europa.eu/tools-and-data/occupational-pensions-statistics_en
Eling M, Luhnen M (2010) Efficiency in the international insurance industry: a cross-country comparison. J Bank Finance 34(7):1497–1509. https://doi.org/10.1016/j.jbankfin.2009.08.026
Eling M, Schaper P (2017) Under pressure: how the business environment affects productivity and efficiency of European life insurance companies. Eur J Oper Res 258(3):1082–1094. https://doi.org/10.1016/j.ejor.2016.08.070
Economic Policy Committee (2020) The 2021 aging report: underlying assumptions and projection methodologies. Institutional Paper 142, November 2020. https://doi.org/10.2765/733565
Commission E (2020) Study on the pension reforms in Greece during the economic adjustment programs: 2010–2018. Publications Office of the European Union, Luxembourg
European Parliament E (2014) Pension schemes. European Parliament, Brussels
Feldstein M (1980) The effect of social security on saving. Geneva Pap Risk Insur Issues Pract 5(1):4–17
Finance H, Network C (2020) The household finance and consumption survey: methodological report for the 2017 wave. ECB Statistics Paper. No. 35
Garcia MTM (2010) Efficiency evaluation of the Portuguese pension funds management companies. J Int Finan Mark Inst Money 20(3):259–266. https://doi.org/10.1016/j.intfin.2010.03.003
Gökgöz F (2010) Measuring the financial efficiencies and performances of Turkish funds. Acta Oeconomica 60(3):295–320. https://doi.org/10.1556/aoecon.60.2010.3.4
Gurol B, Muge I (2018) Measuring the performance of private pension sector by TOPSIS multi criteria decision-making method. J Econ Finance Account 5(3):288–295. https://doi.org/10.17261/Pressacademia.2018.937
Hellenic Statistical Authority (2021) Labour force survey—Q4 2020. Press release, 24.03.2021. www.statistics.gr
Holzmann R, Orenstein MA, Rutkowski M (eds) (2003) Pension reform in Europe: process and progress. World Bank Publications, Washington
Kaffash S, Azizi R, Huang Y, Zhu J (2020) A survey of data envelopment analysis applications in the insurance industry 1993–2018. Eur J Oper Res 284(3):801–813. https://doi.org/10.1016/j.ejor.2019.07.034
Kangur MA, Kalavrezou N, Kim MD (2021) Reforming the Greek Pension System. IMF Working Papers, 2021, vol. 188, A001. https://doi.org/10.5089/9781513588841.001
Lyberaki A, Tinios P (2012) Labour and pensions in the Greek crisis: the microfoundations of disaster. Südosteur J Polit Soc 60(3):363. https://doi.org/10.1515/soeu-2012-600307
Milonas NT, Papachristou GA, Roupas TA (2009) Fund management and its effect in the Greek social security system. J Pens Econ Finance 8(4):485–500. https://doi.org/10.1017/S1474747207002855
Mitchell OS, Andrews ES (1981) Scale economies in private multi-employer pension systems. ILR Rev 34(4):522–530. https://doi.org/10.2307/2522475
Naushad M, Farini MR, Faisal S (2020) Measuring the managerial efficiency of insurance companies in Saudi Arabia: a data envelopment analysis approach. J Asian Finance Econ Bus 7(6):297–304. https://doi.org/10.13106/jafeb.2020.vol7.no6.297
Nektarios M, Tinios P (2019) The Greek pension reforms: crises and NDC attempts awaiting completion. Social Jobs & Protection Discussion Paper, No. 1906, World Bank Group, Washington, D.C. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/572351556878896140/the-greek-pensionreforms-crises-and-ndc-attempts-awaiting-completion
OECD (2013) Pensions at a Glance 2013: OECD and G20 indicators. OECD Publishing. https://doi.org/10.1787/pension_glance-2013-en
OECD (2018a) Pensions Outlook 2018. OECD Publishing. https://doi.org/10.1787/pens_outlook-2018-en
OECD (2018b) Pension Market in Focus 2018. OECD Publishing
OECD (2019) Pensions at a Glance 2019: OECD and G20 indicators. OECD Publishing. https://doi.org/10.1787/b6d3dcfc-en
OECD (2020) OECD economic surveys: Greece, July 2020. OECD Publishing
OECD (2021) Pensions at a Glance 2021: OECD and G20 indicators. OECD Publishing. https://doi.org/10.1787/ca401ebd-en
OECD (2022) Pension Market in Focus 2022. OECD Publishing

Panageas S, Tinios P (2017) Pensions: arresting a race to the bottom. In: Meghir C, et al (eds) Beyond austerity: reforming the greek economy. MIT Press, pp 459–516. https://doi.org/10.7551/mitpress/10082.001.0001
Pavolini E, Seeleib-Kaiser M (2018) Comparing occupational welfare in Europe: the case of occupational pensions. Soc Policy Admin 52(2):477–490. https://doi.org/10.1111/spol.12378
Raab RL, Lichty RW (2002) Identifying subareas that comprise a greater metropolitan area: the criterion of county relative efficiency. J Reg Sci 42(3):579–594. https://doi.org/10.1111/1467-9787.00273
Rahman AM (2018) Voluntary insurance for ensuring risk-free on-the-go banking services in market competition: a proposal for Bangladesh. J Asian Finance Econ Bus 5(1):17–27. https://doi.org/10.13106/jafeb.2018.vol5.no1.17
Scharfstein DS (2018) Presidential address: PENSION policy and the financial system. J Financ 73(4):1463–1512. https://doi.org/10.1111/jofi.12710
Seiford LM, Thrall RM (1990) Recent developments in DEA: the mathematical programming approach to frontier analysis. J Economet 46(1–2):7–38. https://doi.org/10.1016/0304-4076(90)90045-U
Sotiropoulos DA (2004) The EU's impact on the Greek welfare state: Europeanization on paper? J Eur Soc Policy 14(3):267–284. https://doi.org/10.1177/0958928704044627
Symeonidis G, Tinios P, Xenos P (2021) Enhancing pension adequacy while reducing the fiscal budget and creating essential capital for domestic investments and growth: Analysing the risks and outcomes in the case of Greece. Risks 9(1):1–1. https://doi.org/10.3390/risks9010008
Thomas A, Spataro L (2016) The effects of pension funds on markets performance: a review. J Econ Surv 30(1):1–33. https://doi.org/10.1111/joes.12085
Tinios P (2016) The Greek pension tragedy: a case of failure in Governance. Konrad Adenauer Stifftung, Katoptron, 4
Wanke P, Barros CP (2016) Efficiency drivers in Brazilian insurance: a two-stage DEA meta frontier-data mining approach. Econ Model 53:8–22. https://doi.org/10.1016/j.econmod.2015.11.005
World Bank (1994) Averting the old age crisis: Policies to protect the old and promote growth. Oxford University Press, Oxford

References in the Greek language

FEIR (2022) *Occupational insurance in Greece: Challenges and prospects*. FEIR.
Giannitsis, T. (2016). *The Pension Problem and the Crisis*. Papazisis.
Government Official Journal. (2002). Law 3029: Issue 106. Athens, Greece, July 7, 2002. Retrieved from www.et.gr.
Government Official Journal. (2010). Law 3865: Issue 120. Athens, Greece, July 21, 2010. Retrieved from www.et.gr.
Government Official Journal. (2012). Law 4052: Issue 41. Athens, Greece, February 22, 2013. Retrieved from www.et.gr.
Government Official Journal. (2014). Law 4261: Issue 107. Athens, Greece, May 5, 2014. Retrieved from www.et.gr.
Government Official Journal. (2016). Law 4387: Issue 85. Athens, Greece, May 12, 2016. Retrieved from www.et.gr.
Government Official Journal. (2017). Law 4472: Issue 74. Athens, Greece, May 19, 2017. Retrieved from www.et.gr.
Government Official Journal. (2020). Law 4680: Issue 72. Athens, Greece, March 23, 2020. Retrieved from www.et.gr.
Government Official Journal. (2021). Law 4826: Issue 160. Athens, Greece, September 7, 2021. Retrieved from www.et.gr.
Hellenic Association of Insurance Companies. (2020). Annual Statistical Report 2020. Retrieved from http://www1.eaee.gr/sites/default/files/annual_stat_report_2020_gr.pdf.
HUIORP. (June 2019). *Occupational Pension Funds in Greece: Assessments and Perspectives*. HUIORP.
Pissarides, Chr., Vafianos, D., Vettas, N., & Megir, K. (2020). Growth plan for Greek economy, intermediate report. Retrieved from https://government.gov.gr/schedio-anaptixis-gia-tinelliniki-ikonomia-endiamesi-ekthesi.
Robolis, S., & Betsis, V. (2016). *The social insurance Odyssey*. Livanis.
Romanias, G. (2007). *Greek and European Myths about Social Security*. Vlassi Publishers.

Authors and Affiliations

Chrysanthopoulou Xakousti[1] · Mavrommati Athanasia[2] · Migdalas Athanasios[3]

✉ Chrysanthopoulou Xakousti
xeniachrysanth@yahoo.gr

Mavrommati Athanasia
amavrom123@gmail.com

Migdalas Athanasios
athanasios.migdalas@ltu.se

[1] Department of Economics, Aristotle University of Thessaloniki, Thessaloniki, Greece

[2] Department of Business Administration of Food and Agricultural Enterprises, University of Patras, Agrinio, Greece

[3] Department of Social Sciences, Technology and Arts, Luleå University of Technology, Luleå, Sweden