Evaluation of the Efficiency of Pension Funds:

Systematic Literature Review

Diogo de Menezes Cortês Bezerra, Alexandro Barbosa
(Universidade Federal do Rio Grande do Norte, Brazil)

Abstract: In the last two decades, supplementary pension started having a bigger impact on society due to changes which happened in the official pension. This is a trend which affects both developed and developing countries. The concern related to the supplementary income during retirement resulted in the increase of pension fund memberships. Regarding a social and a financial standpoint, these pension funds have become striking. This paper aimed to carry out a systematic literature review about the evaluation of the efficiency of pension funds, seeking to identify patterns of objectives, methodologies, results and tendencies associated with them. In order to achieve the aim, 14 papers from five different bibliographic databases were selected. The papers were analyzed from three different perspectives: bibliometric analysis, correspondence analysis and content analysis. The results showed that the studies about the pension funds are still preliminary. However, considering the most utilized methodology (Data Envelopment Analysis), patterns have already been identified. Furthermore, it is also understood that the research of the evaluation of funds must thrive from an academic point of view, because the lack of standardization of analysis not only generates gaps in the literature, but also hinders the comparison among funds from varied perspectives.

Key words: evaluation, efficiency, pension funds, supplementary pension, benefits

JEL codes: O15, R23

1. Introduction

Social security is a topic of paramount importance, both from a social and an economic perspective. According to Oliveira and Beltrão (2000), every citizen has an interest in knowing whether, once their work capacity is diminished or terminated, they will have a stream of income to compensate for the change in their earnings or if their family will be supported in their absence. From an economic standpoint, social security systems involve significant financial transactions, and their management constitutes a field of constant political contention (Rogieri, 1998).

In Brazil, Social Security is organized in the Federal Constitution through three main fronts. The first is the General Social Security Regime (RGPS), mandatory for all workers subject to private law. The second is the Special Social Security Regime (RPPS), also mandatory, but this time for public servants. It regulates the pensions

---

Diogo de Menezes Cortês Bezerra, Doctoral Student, Universidade Federal do Rio Grande do Norte; research area: finance. E-mail: diogomenezes90@gmail.com.

Alexandro Barbosa, Doctor, Universidade Federal do Rio Grande do Norte; research area: finance. E-mail: alexufrnet@gmail.com.

of all permanent public servants at the federal, state, and municipal levels. Finally, there is the third front, the Supplementary Social Security Regime (RPC), which is voluntary and aims to generate value and provide supplementary benefits to the insured.

The Supplementary Social Security Regime (RPC) can be further divided into two forms: open membership entities, typically operated by financial institutions, and closed, nonprofit entities exclusive to employees of certain companies and institutions, commonly known as pension funds. As emphasized by Lima and Diniz (2016), the RPC operates autonomously in relation to Social Security. Beltrão et al. (2004) add that private pension plans have grown in relative importance in the national economy, accompanied by developments in legislation.

According to Winklevoss (1993), the population participating in pension fund benefit plans can be classified into several subpopulations. The first group consists of those still working for the sponsoring companies, the active members of pension plans. Another important subpopulation for benefit plans is the assisted members, those who have reached retirement within the company. A third group is formed by those who have terminated their employment contracts with the company and are in the deferred benefit period.

Both the RGPS and the RPPS operate under the pay-as-you-go financing system, known as the repartition system. This means that the active population finances benefits paid to the inactive population through monthly contributions without capitalization of reserves. In return, these workers acquire the right to receive a retirement benefit in the future.

Bértin and Perroto (2003) further clarify that in a system under the repartition regime, active workers make contributions that, together with those of employers, will finance retirement benefits for individuals currently entitled to them. However, with the aging population and increasing life expectancy, this financing system has become increasingly unfeasible and, consequently, more discredited by society. According to Thomas et al. (2014), this is the main reason why developed and developing countries have undergone significant reforms in their social security systems over the past 20 years.

Given this context, individuals and organizations increasingly seek complementary forms of security to maintain their resources in retirement. Sass (1997) points out that closed supplementary pension entities, also known as pension funds, promote the complementarity of retirement benefits. Amidst this situation, supplementary pension plans have gained strength and increased their adoption by various individuals and institutions.

For Dietrich and Baido (2016), retirement planning is an important means of maintaining income during retirement. Individuals participate in supplementary pensions primarily with the goal of savings. The supplementary pension system has gained greater importance in recent times due to the unsustainability of basic social security system accounts and the expansion of regulatory changes that encourage this system in Brazil and worldwide. Pension funds are nonprofit and have the sole purpose of providing their participants with supplementary income to mandatory pension benefits. Therefore, monitoring economic and financial performance is important to ensure the use of the allocated resources when necessary (De Conti, 2016).

There are studies evaluating Brazilian pension funds from different perspectives. Socioeconomic determinants of individuals' choice to invest in private pensions in Brazil were analyzed by Costa and Soares (2017) using logistic regression with data from the National Household Sample Survey (PNAD) from 2011. The researchers found that elements such as income level, educational attainment, and age exert a positive influence on individuals' decision-making. This highlights the importance of managers considering income growth trends, educational level, and population aging when developing retirement planning strategies.

De Almeida et al. (2017) sought to identify the types of pension funds existing in Brazil, the main differences between them, and how they disclose their economic and financial results to the target audience. The research conducted an exploratory and descriptive study on two pension funds in the supplementary pension regime: one from closed funds, PREVI, from Banco do Brasil, and another from open funds, Bradesco Vida e Previdência. The results showed that pension funds disclose financial statements, reports, and mandatory opinions. Both used different methods of disclosure, including formats and arrangements of financial statements, explanatory notes, supplementary statements and tables, reports from independent auditors, among others.

Diniz and Corrar (2017) measured and evaluated the efficiency of Brazilian Closed Supplementary Pension Entities (EFPCs), aiming to identify their determinants. They explored the relationship between size, sponsorship, investments, and EFPC efficiency. The research was conducted with a sample of 92 pension funds from 2010 to 2013. They found that larger pension funds have significantly higher average efficiency than smaller ones.

Nese (2017) explored the association of governance practices and specific characteristics of Brazilian pension funds with investment performance. Their results showed a positive relationship between investment performance and the use of better governance practices.

Outside Brazil, Siddiqui (2022) analyzed the efficiency of Indian pension funds focusing on health through Data Envelopment Analysis (DEA), using management indicators to analyze efficiency with efficiency and productivity performance analysis of 27 health insurers from 2015 to 2019 using data envelopment analysis-based slack-based measures. The Malmquist index was used to assess the productivity of health insurers. The Mann-Whitney test was used to investigate the cluster hypothesis versus the strategic focus hypothesis. The results indicated that the Indian health insurance industry experienced significant fluctuations in average technical efficiency during the study period. Nearly 30% of health insurers operated efficiently.

Lu et al. (2021) used network DEA to measure administrative efficiency of outsourced management funds and self-managed funds in Taiwan. The study established a selection mechanism for pension fund outsourcing that complies with current outsourcing management policies, considering both security and profitability.

It is observed that there is no standard evaluation model for pension funds in scientific research. It is in this context that the present research fits, presenting a systematic literature review aimed at identifying patterns of pension fund efficiency analysis. To achieve this goal, this study aims to answer three questions: What are the objectives of pension fund efficiency evaluation? What types of methodologies are used for efficiency measurement? And what are the main findings and trends in pension fund efficiency evaluation? The literature review was constructed from 14 national and international articles, which were found in searches on the CAPES periodicals portal, Web of Science, Scopus, Scielo, and Google Scholar.

2. Methodology

This work is characterized as bibliographic and reflects the results of a systematic literature review. The material used was obtained through searches on five distinct bibliographic databases: CAPES Journals, Scielo, Google Scholar, Web of Science, and Scopus. The first three provided results of national origin, important for gaining an overview of the researched topic in the country. Meanwhile, Web of Science and Scopus provided an international perspective on the evaluation of financial and administrative efficiency of pension funds. No time restrictions were imposed on the searches, considering all works collected up to the day of the research.

On the CAPES Journals portal, the search was conducted on April 16, 2022, using the terms "pension funds" in the title, "efficiency", and "financial indicators" in any field. The search returned 5 results. Then, on April 18, 2022, searches were performed on the Web of Science database using the terms "pension funds", "performance", "financial", and "efficiency", which returned 14 texts with these terms in the title, abstracts, or keywords.

On April 22, 2022, the Scopus database was used to search for the terms "pension funds", "performance", "financial", and "efficiency" included in titles, abstracts, and keywords. The search returned 9 scientific articles. The search on Scielo, on April 24, 2022, using the terms "pension funds", "performance", "financial", and "efficiency" included in titles, abstracts, and keywords, did not return any work. Finally, on April 28, 2022, the search on Google Scholar resulted in 3 works based on the criteria of "pension funds" and "efficiency" in the title of reviewed articles.

Based on the results obtained and with the search parameters properly delimited in each database, the process of excluding irrelevant articles for research began in stages. The following criteria were applied:

Unavailability of the text;

Studies not associated with policies of financial evaluation and efficiency of the funds;

After excluding unavailable works, the results found totaled 25 articles, of which 4 were excluded for being repeated in different databases, leaving 21 articles. The eligibility stage followed, where 9 articles were excluded for being outside the theme of administrative and financial efficiency evaluation of pension funds. As a result, we ended up with a total of 14 articles addressing this theme.

The schematic summary of the selection stages of this material can be seen in Figure 1, following the structure and content of a systematic literature review as defined by Roever (2017).
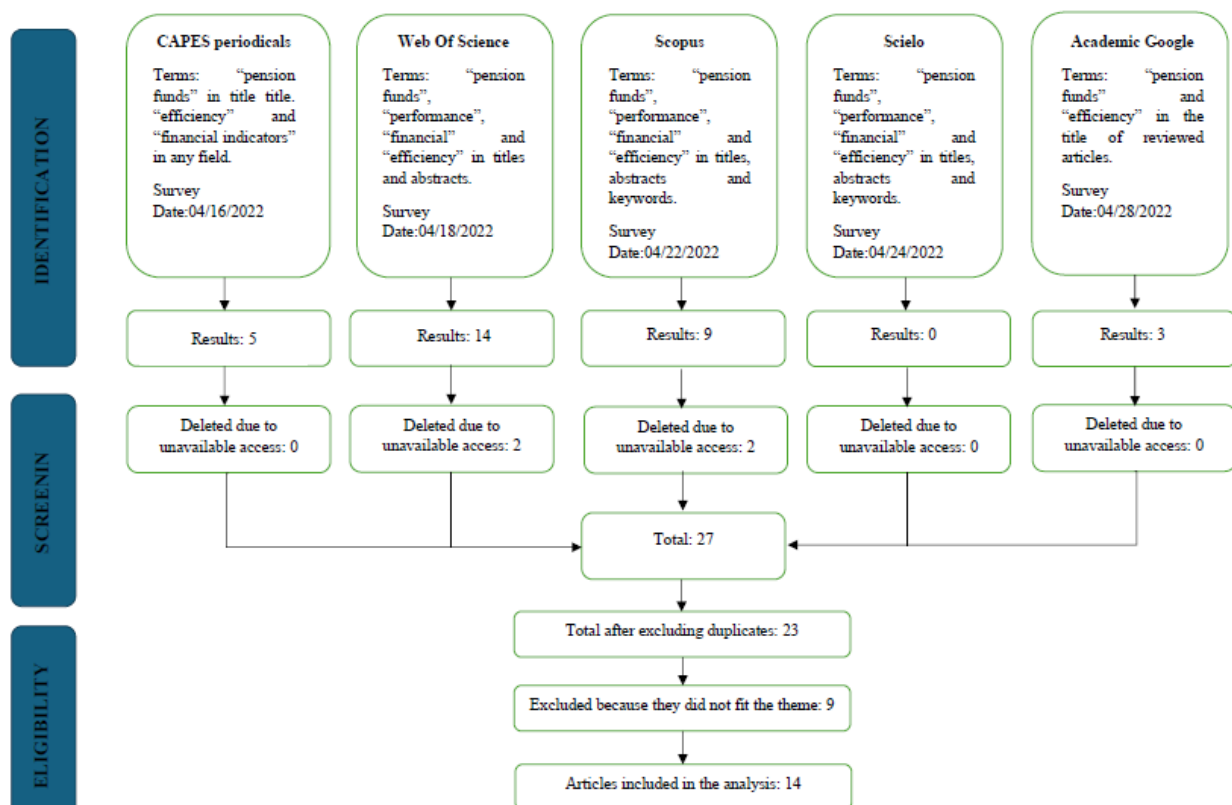

Figure 1   Material Selection Steps

From the selected texts, observations were made to identify the results, explanations, and responses regarding the aspects addressed by the researches. As outlined in the subsequent sections, both quantitative and qualitative analyses are presented to demonstrate the concepts.

3. Results and Discussions

The research results will be presented within three categories. Firstly, a bibliometric analysis followed by a correspondence analysis of the selected articles in stage 4 of the research protocol, concluding with a systematic review of these articles based on a content analysis approach.

3.1 Bibliometric Analysis

Bibliometric studies aim to understand how one property behaves relative to another already known. Thus, in the case of scientific publications, one may aim to understand all the authors who have worked on a particular subject; the journals that have published on this subject; the authors considered as references on the subject; the authors of this subject who have published in a particular journal, and so on, and cross-reference these properties (Macias-Chapula, 1998). Therefore, the use of quantitative methods in the pursuit of an objective evaluation of scientific production is the central point of bibliometrics. It is noteworthy that the Web of Science platform returned the most scientific articles on the researched topic, followed in sequence by Scopus, CAPES Platform, and Google Scholar. The Scielo database did not return any articles for the article search. The mentioned information can be observed in Figure 2.
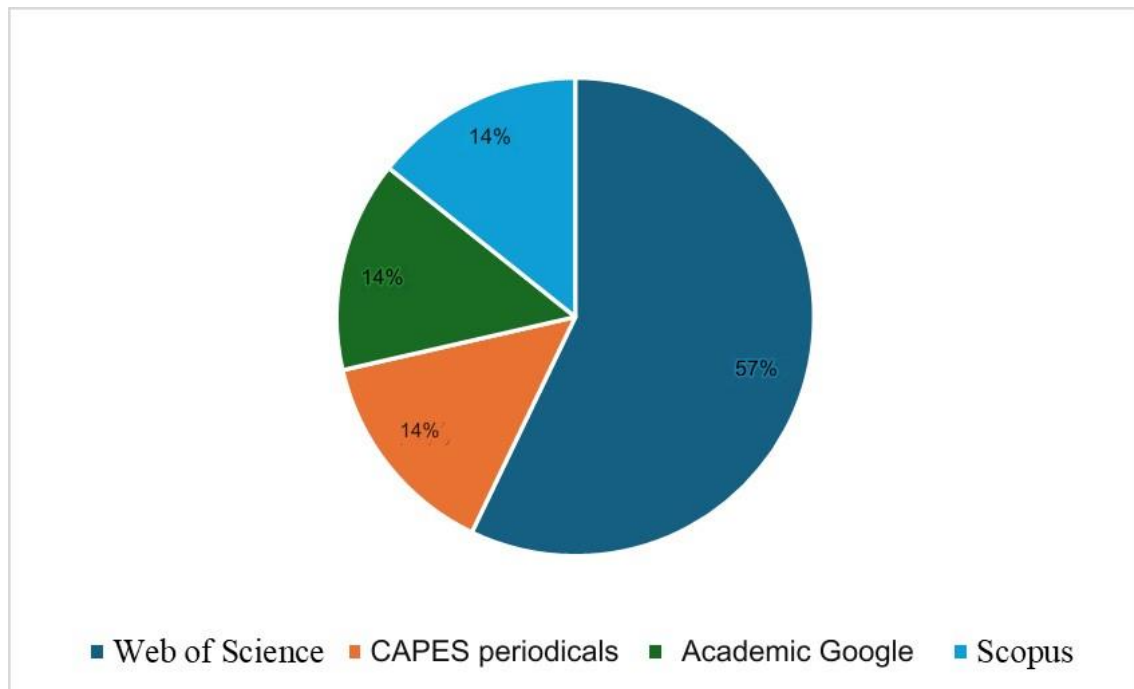

Figure 2   Percentage of Articles Included by Search Base

Another important observation concerns the publication year of the selected texts. It is noteworthy that no texts were excluded based on the year criterion, leaving the research open. The oldest text was from the year 2008, and the most recent was from 2022. This reveals that the topic is current and has been relatively under-discussed

in the literature. It is important to highlight that from 2019 to 2022, there were publications every year in the field, as shown in Figure 3, indicating a trend of growth in publication and research in the related area.
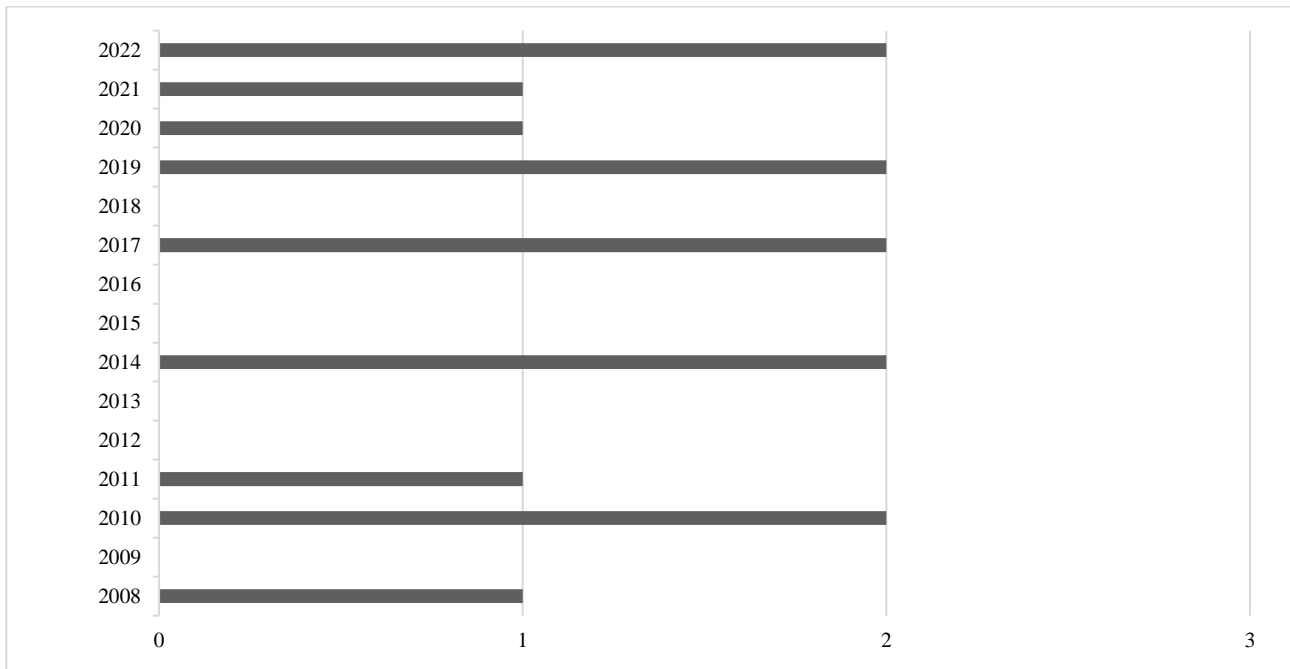

Figure 3   Year of publication of Studies

Regarding the original countries of the analyzed studies, a predominance of Brazilian studies is noted. This trend may be attributed to the fact that, within the consulted databases, two were exclusively Brazilian (CAPES Journals and Google Scholar), and were searched using terms in Portuguese. However, it is observed that countries in North and Central America, as well as European, Middle Eastern, and Asian countries, have also conducted research on the topic, as shown in Figure 4. Additionally, as emphasized by Lavinas and Araújo (2017), successive pension reforms attract the attention of Brazilians to social security.
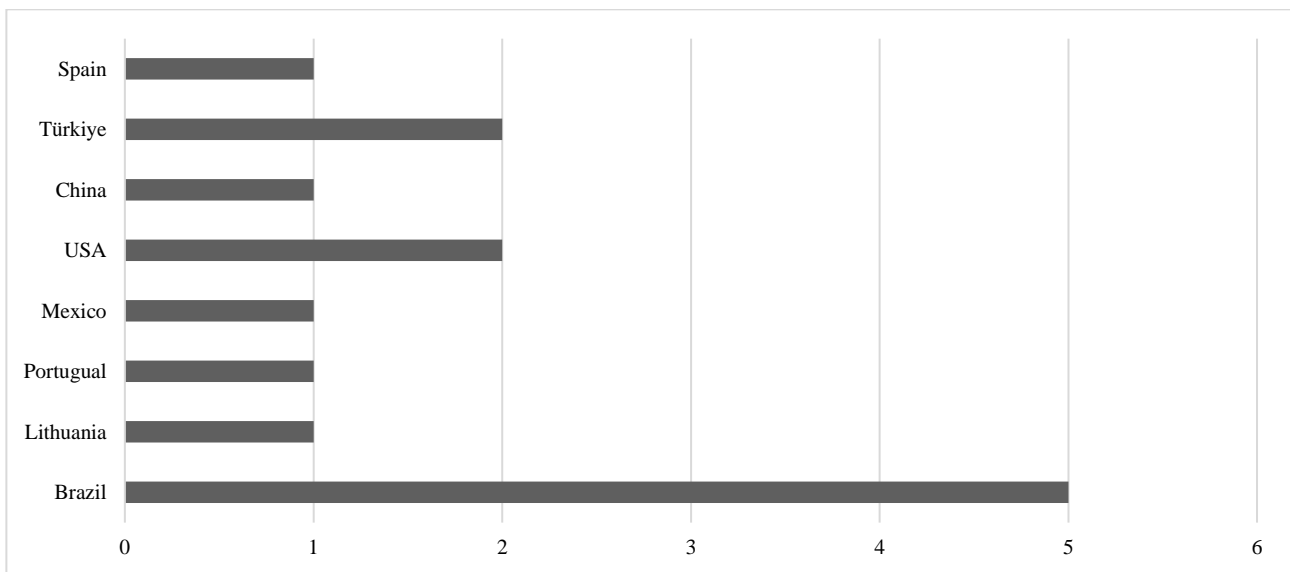

Figure 4   Countries of Publication of the Studies

3.2 Correspondence Analysis

In this stage, the statistical method of Correspondence Analysis was applied, an exploratory technique developed to analyze contingency tables with double and multiple entries, through some measures of correspondence between rows and columns (Greenacre, 2016). Correspondence analysis enables obtaining a multidimensional graphical representation of the dependence between the rows and/or columns of a contingency table with two entries, where the rows and columns represent categories, modalities, of categorical variables. Correspondence analysis is a factorial analysis method for categorical variables, that is, non-continuous or discretized. The graphical representation is obtained by the distribution of scores of row and column categories, marking these categories as points, where the scores are used as the coordinates of these points.
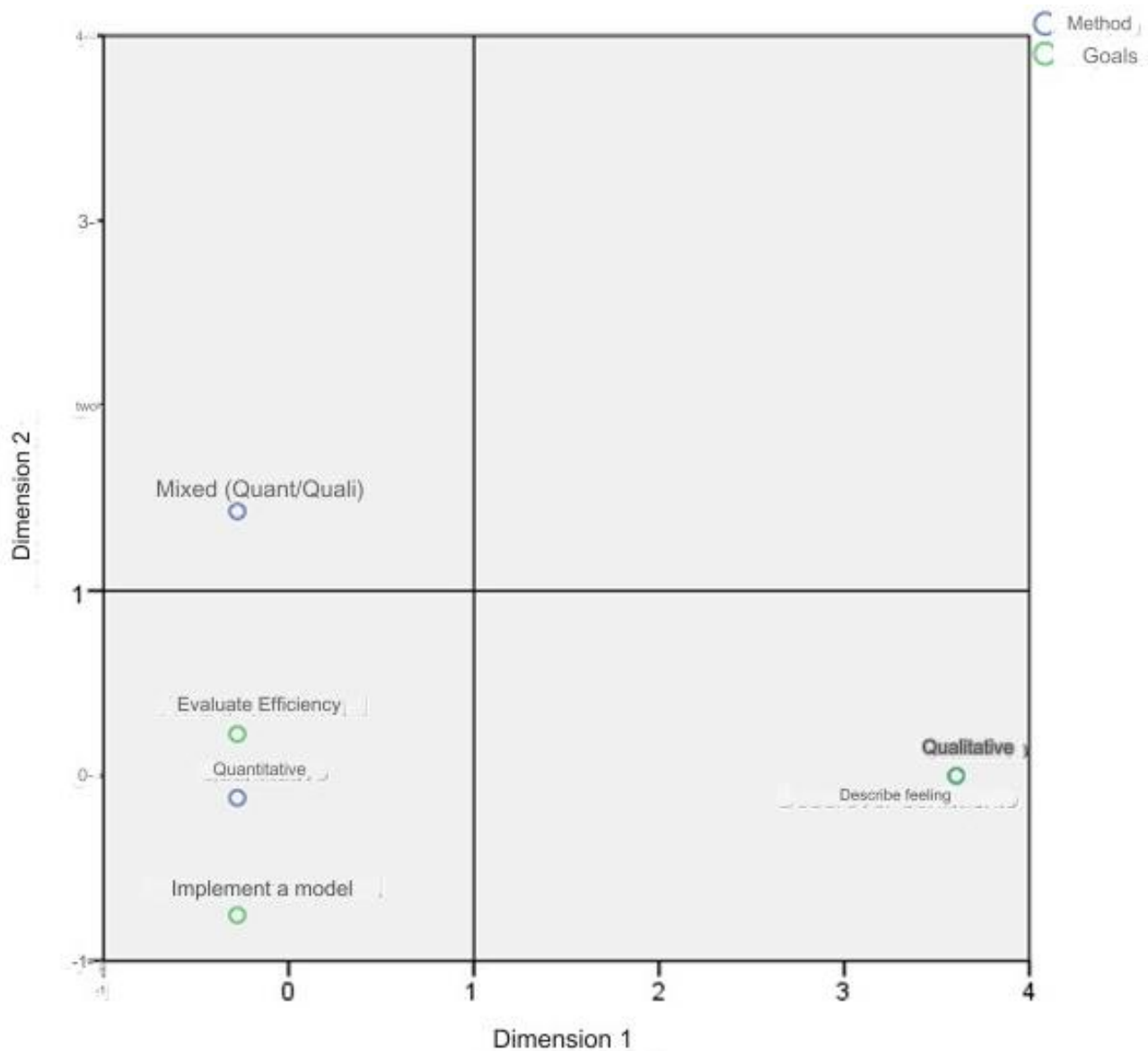

Figure 5   Correspondence Between Methods and Objectives

In Table 1, the observed frequency, expected frequency, adjusted, and standardized residuals for the analyzed variables are presented concerning the research objective and the method employed in the study. The table indicates a pronounced tendency towards quantitative research for pension fund analysis. Furthermore, a significant portion of the studies focuses on assessing fund efficiency using methods already established in the literature.

Table 1   Frequency Table

			Objectives			
			Evaluate fund efficiency	Implement a new efficiency model	Describe the perception of fund investors	Total
Method	Quantitative	Frequency	9	3	0	12
		Expected Frequency	8.6	2.6	0.9	12.0
		Waste	0.4	0.4	-0.9	
	Qualitative	Frequency	0	0	1	1
		Expected Frequency	0.7	0.2	0.1	1.0
		Waste	-0.7	-0.2	0.9	
	Mixed	Frequency	1	0	0	1
		Expected Frequency	0.7	0.2	0.1	1.0
		Waste	0.3	-0.2	-0.1	
Total		Frequency	10	3	1	14
		Expected Frequency	10.0	3.0	1.0	14.0

These Correspondence Analysis procedures, through the statistical analysis applied with the variables of this research, led to the output presented in Table 2, with a Pearson Chi-square value of 14.35 and a total inertia of 1.025, across two dimensions. Inertia is defined as a measure of dispersion among the variables in the table given by the Pearson Chi-square ($\chi2$) divided by the total frequencies (n). Furthermore, if we choose the null hypothesis (H0) that there is no relationship of dependence between variables of "Methods" and "Objectives" in pension fund efficiency research, this hypothesis can be rejected at a 95% confidence level, as the two-tailed asymptotic significance or p-value is less than 0.05. In other words, there is an association of dependence between the qualitative variables analyzed in this context.

Table 2   Dependence Relationship Between the Qualitative Variables

Dimension	singular value	Inertia	chi -square	sig. Assi. P-value	inertia ratio accounted for	Cumulative	Unique value of trust Standard deviation	Correlation 2
1	1,000	1,000			0.976	0.976	0.000	0.000
2	0.158	0.025			0.024	1,000	0.090	
Total		1.025	14,350	0.006	1,000	1,000		
The. 4 degrees of freedom								

The correspondence between statistically significant variables of method and research objective reinforces the idea that researchers have been focusing on developing an effective method for measuring efficiency within various pension fund contexts, yet they have not reached a consensus. The lack of studies on pension fund efficiency is striking, especially considering the changing pension model due to the increasing life expectancy of individuals and the growing social importance of pension funds.

3.3 Systematic Analysis

After the initial quantitative analysis, a qualitative analysis was carried out, focusing on content analysis to establish existing and new categories (Bardin, 2016) within the studied fields, thus obtaining insights about the nature of research, its trends and limitations.

3.3.1 Objectives and Methods of the Studies

The studies included in the survey have varied objectives when it comes to pension fund valuation. The evaluation perspectives vary both in relation to the objective of the research and in relation to the method. Regarding the approach, the studies taken into account are predominantly quantitative, only 2 studies used qualitative or mixed methods to complement the analyses.

The analysis of the objectives of studies that aim to measure the efficiency of pension funds reveals a diversified panorama in the different study perspectives. This reveals that, despite the purpose of the studies being the evaluation of funds, the forms and methods for this verification are wide and happen in different scenarios, as we observe in Tables 3 and 4.

Table 3   Objectives of the Analyzed Articles

Type of approach	Objectives	Authors
Quantitative	1- Find out if the allocation of resources from pension funds is being done efficiently according to the portfolio theory. 2- Find out if there is a need for greater diversification of assets, enabling the inclusion of foreign assets. 3- Find out whether the limits of regulation are causing or could cause any restrictions on the efficient allocation of funds.	Silva and Oliveira (2011)
Quantitative	Measure and evaluate the efficiency and identify the efficiency determinants of Closed Supplementary Pension Entities (EFPC) in Brazil. The study explored the relationship that: size, type of sponsorship (private or public) and investment profile (variable income, fixed income or other types) can exert on efficiency over (EFPC).	Diniz and Corrar (2017)
Quantitative	Analyze the operational efficiency of the EFPC Funds during the years 2015 and 2016 in Brazil and present with possible determinants.	Silva *et al* . (2019)
Quantitative	Develop and implement an efficiency assessment concept model for financial alliances based on the assessment of Bancassurance efficiency in managing pension funds in the Baltic countries.	Arefjevs (2017)
Quantitative	Analyze the comparative efficiency of Portuguese pension fund management, assessing the sector's efficiency using a variety of metrics to measure inflows and outflows that combine financial and operational dimensions. In addition, the total productivity is evaluated with the Malmquist index .	Garcia (2010)
Quantitative	Test the mean-variance efficiency that the Mexican public pension would have shown if they invested their local stock portfolio component only in responsible stocks (shares of companies with social responsibility).	De la Torre-Torres, Galeana -Figueroa and Álvarez-García (2019)
Qualitative	Present insights into well-governed financial institutions, specifically public and private pension funds, with implications for best practice, as illustrated by four case studies of funds from Canada, Europe, and the United States.	Clark (2008)
Quantitative	Establish a selection mechanism for outsourcing Taiwanese pension funds that complies with current outsourcing management policies and considers both safety and profitability.	Lu, Kweh and Wang (2021)
Quantitative	Evaluate the effectiveness of investment fund selection techniques from the perspective of Brazilian pension funds.	Saints of Paula and Iquiapaza (2022)
Mixed (Qualitative/ Quantitative).	To investigate private pension fund investors' sentiment towards fund performance and cost in an environment of frequent regulatory changes. The analyzes are conducted in a low-return, high-cost private pension market environment, which facilitates the observation of the relationship between investor sentiment about return and cost.	Erzurumlu and Ucardag (2021)

(Table 3 to be continued)

(Table 3 continued)

Quantitative	To investigate the impact of pension governance practices on the performance of the public defined benefit pension fund (DBP).	Xu et al.. (2020)
Quantitative	Analyze the risk of the pension fund with and without futures contracts on the IBOVESPA, and evaluate the gains obtained in the risk/return ratio by a proposed sectorial approach.	Costa, Santos and Silveira (2014)
Quantitative	Measure and compare the financial efficiencies of Turkish bonds and pension funds in the period 2006-2007.	Gokgöz (2010)
Quantitative	Tone's variants of the slack-based efficiency measure for the first time to a real-world problem to assess the efficiency of one of the most relevant decisions in pension fund management: the strategic allocation of assets.	Andreu, Sarto and Vicente. (2014)

Table 4   Methods of the Analyzed Articles

Authors	Methods
Silva and Oliveira (2011)	Given the secrecy of information at the time of the pension fund assets, the authors estimated the investment percentage of each fund in 4 modalities (1-Fixed Income, 2-Variable Income, 3-Real Estate and 4-Operations with participants.) according to information obtained from the secretariat of supplementary pensions. As well as, they established scenarios for the calculation of the efficient frontier in comparison to the economic stability of the country. The authors simulated the efficient frontiers using the portfoliowork software recommended by the version of the methodology recommended by Markowitz.
Diniz and Corrar (2017); Silva *et al.* (2019); Xu *et al* . (2020); Gokgöz (2010)	Date Envelopment Analysis (DEA)
Arefjevs (2017)	Frontier-based efficiency measurement techniques - Stochastic Frontier Analysis and Data Envelopment Analysis (DEA)
Garcia (2010)	Malmquist productivity index (Malmquist , 1953) based on data envelopment analysis (DEA).
De la Torre-Torres; Galeana -Figueroa; Álvarez-García (2019)	S&P Mexican Risk Index.
Clark (2008)	Case studies-funds from Canada, Europe and the United States.
Lu et al. (2021)	Network Dynamic DEA and set theory.
Santos of Paula and Iquiapaza (2022)	(I) Sharpe Ratio; (II) alpha of a multifactorial model; (III) efficiency of data envelopment analysis (DEA, data envelopment analysis); and (IV) the different combinations of these techniques.
Erzurumlu and Ucardag (2021)	Effect panel data analyzes of all Turkish private pension funds from 2011 to 2019.
Costa, Santos and Silveira (2014)	Markowitz portfolio theory.
Andreu, Sarto and Vicente (2014)	Efficiency measure based on slack.

Regarding the methods used in the studies, there is a pattern for Data Envelopment Analysis (DEA), (Diniz and Corrar (2017); Silva et al. (2019); Xu et al. (2020); Gökgöz (2010)). However, it is observed that the Data Envelopment Analysis method was used in conjunction with other methods in several cases, as was the case of Garcia (2010) using the Malmquist productivity index , Santos de Paula and Iquiapaza (2022) used with the Sharpe index, Costa, Santos and Silveira (2014) used the portfolio theory to verify the efficiency in comparison to the Mexican market risk, among other combinations as we can see in Table 1. It is noted that the valuation of funds follows comprehensive and diversified forms of measurement, the only method that can be considered almost as a consensus is the Data Envelopment Analysis.

3.3.2 Main Results of the Studies

Within the very core of the current work, Table 3 presents the main results presented in the articles analyzed and that reveal the findings of the studies. The first pertinent observation is that, due to the variation in methods

and countries, it is difficult to find a clear and comparative pattern between studies. The analysis perspectives regarding efficiency are very varied and the variables analyzed are as diverse as their analysis. While Diniz and Corrar (2017), Silva and Oliveira (2011), Costa, Santos and Silveira (2014) and Santos de Paula and Iquiapaza (2022) study financial variables of fund performance, Arefjevs (2017) classifies efficiency according to the background size. Lu et al. (2021) takes into account whether or not the fund has better efficiency with respect to its outsourcing and domestic investment. De la Torre-Torres; Galeana -Figueroa; Álvarez-García (2019) assesses whether the fund obtains better efficiency by investing in socially responsible companies. Costa, Santos and Silveira (2014) compares the average daily return with hedge is higher than without hedge. As there is no evaluation standard, the results are also extremely diverse. The only study that tries to launch itself as a model methodology for valuing pension funds is the study by Diniz and Corrar (2017), which analyzes the book value of assets as well as aspects such as size, type of sponsorship (private or public) and the investment profile (variable income, fixed income or other types).

In general, there is a large methodological gap regarding the assessment of pension funds at an international level. This gap is revealed by several indications that occurred in the study. First, the lack of a methodological standard, then the evaluation variables, the analysis perspective, and the results found.

Table 5   Main Results

Authors	Main results
Silva and Oliveira (2011)	The results provided evidence that, in any scenario, pension funds can further improve resource allocation efficiency to obtain better returns. Especially in a scenario of stability, with interest rates lower than 4%, showing that it is essential to allocate resources in foreign assets, improving the fund's performance.
Diniz and Corrar (2017)	It shows that scale, measured by the book value of assets, is positively related to efficiency. This conclusion is in line with that obtained in the study by Barros (2010) for the case of Portuguese pension fund managers who also measured the scale by the book value of assets.
Silva et al. (2019)	Among the elements tested by the hypotheses, the highlight is the significant inefficiency of the larger EFPC compared to the smaller ones. Although this result appears to be contrary to that presented in Diniz and Corrar (2017) and in Barros (2010), the study considered each year separately, diverging from the methods used in the mentioned articles. An equally important result in this study was to observe that the sponsorship of the EFPC was not the determinant for the difference in efficiency. Failure to observe this hypothesis indicates the need to establish more substantive management and governance mechanisms, regardless of the source of sponsorship.
Arefjevs (2017)	Pension fund management companies in the Baltic countries can be classified into four sustainable groups: specialized small and medium-sized companies, large companies with low exposure to fund management businesses, large companies with low to moderate exposure to non-pension management businesses of funds, other companies, including atypical companies, that do not fall into any of the above mentioned groups. Small and medium-sized specialist pension fund companies were able to achieve competitive efficiency relative to other companies because they were featured in the top quartile of companies with the highest efficiency ratings over the survey period, on average comprising 45% of companies. companies associated with the quartile.
Garcia (2010)	(i) In the first group, four pension fund management companies were found in which improvements in technical efficiency coexist with improvements in technology change. These are the best performing pension fund administrators in the period. With registered improvements in technical efficiency, denoting updated organizational factors associated with the use of inputs, outputs and the relationship between inputs and outputs.(ii) In the second group, five pension fund management companies were found in which improvements in technical efficiency coexist with the deterioration of technology. It is a management of pension funds companies with up-to-date organizational factors, but without the innovation inherent in investing in new technologies, which would leverage organizational factors. They need to acquire new technologies and the commensurate skill upgrades needed to improve their performance. (iii) In the third group, two pension fund management companies were found, in which improvements in technological efficiency coexist with deterioration in technical efficiency. This pension fund the management company needs to upgrade its managerial skills and scale to improve its performance.(iv) In the fourth possibility, where the deterioration of technical efficiency coexists with the deterioration of technology, a management company was found.

(Table 5 to be continued)

(Table 5 continued)

De la Torre-Torres; Galeana-Figueroa; Álvarez- García (2019)	origins to real applications that began as activist investing in the 1970s. such in the investment industry. As a result of this evolution and acceptance, several studies have been done to test the adequacy of risk, return, or utility maximization for the individual or institutional investor. One of the main problems of the ISR is that it leads to less diversified portfolios than the conventional ones (portfolios with ISRe not ISR stocks), having an impact on the mean-variance efficiency and, potentially, on the maximization of utility and performance.
Clark (2008)	The author brings successful cases of pension funds that integrate governance and tries to link the performance of the funds.
Lu et al. (2021)	Domestic investment firms exhibited the highest management scores in all situations. Investment companies performed stronger in medium and long-term management and volatility control than investment companies from financial holding companies. Domestic investment firms exhibited higher investment performance scores and less volatility than the other two types of investment firms across all durations.
Santos of Paula and Iquiapaza (2022)	Information from 369 funds from 2013 to 2018 was considered, adopting 12 time windows for portfolio selection and reassessment. The returns obtained were compared with the average actuarial target of benefit plans managed by pension funds, through unplanned divergence (DnP). By outsourcing the allocation of pension funds to fixed income and variable income investment funds, it was found that the Sharpe ratio significantly contributes to the performance of pension funds, compared to other indicators and techniques or their combination.
Erzurumlu and Ucardag (2021)	When regulations provide compensation and improve market efficiency in a market pension fund, the investor's focus shifts from performance to cost. Investors allocate assets relative to the realized return when adequately compensated for risk or with favorable contractual cost provisions. Consequently, investors in pension funds with lower return expectations and without special commission reduction clauses tend to adopt the cost minimization strategy.
Xu et al. (2020)	Using 1,544 manually collected observations in the US from 2002 to 2013, the results show that public defined benefit pension plans with a small board, appointed board directors, and separate investment board exposure perform best.
Costa, Santos and Silveira (2014)	It was noted that the average daily return with hedge is higher than without hedge, however this drop is relatively small compared to the risk of adding these assets.
Gokgöz (2010)	Results from performance indices and DEA models reveal that pension mutual funds exhibit higher portfolio performance and financial efficiencies than SMFs in the 2006-2007 period. However, securities mutual funds and pension mutual funds showed considerable efficiency increases over the 2006-2007 period according to the CCR and BCC models. Of the 77 funds studied, 23 funds in 2007 and 20 funds in 2006 demonstrated scale efficiency.
Andreu, Sarto and Vicente (2014)	The results highlight the relevance of SBM Variação III, which considers clusters of portfolios with similar characteristics, to properly identify the reference set of each portfolio. Therefore, this variant allows the identification of more globally inefficient portfolios. The results also reject the notion of a positive relationship between resource management and strategic investment style efficiency.

3.3.3 Main Limitations and Recommendations for Future Research

In general, the major limitation of pension fund evaluation research concerns the lack of access to data made available by the funds. However, there are limitations regarding the period studied, the territory, the change in regulations, among other limitations.

Regarding recommendations for future research, research suggests replicating the methodologies in other contexts, in other periods and with other perspectives.

Table 6   Search Recommendations

Authors	Study limitations	search recommendations
Silva and Oliveira (2011)	The major limitation of the research was the lack of access to some data that did not faithfully portray the situation of the portfolios in each scenario, consequently their real situation in relation to portfolio theory.	As research recommendations, the authors suggested: 1) Replicating the same methodology for dynamic asset allocation, as well as monitoring the cost linked to portfolio modifications. 2) Impose a budget constraint on asset allocation to the Markowitz model.

(Table 6 to be continued)

(Table 6 to be continued)

Diniz and Corrar (2017)	One of the limitations of this study is the sample of pension funds used. 92 pension funds were researched when the objective was to have used the entire universe, however due to the difficulty in having the data, the present study was limited to a period of four years, that is, from 2010 to 2013.	With regard to the recommendation is that in the first part of the work the focus on production could be chosen instead of intermediation. Some extensions could be made in relation to the present study, such as the use of alternative DEA models, such as the Malmquist Index Model (Malmquist, 1953), the Cross-Efficiency DEA Model and the Super Efficiency DEA Model to measure efficiency scores technique that were used by Barros and Garcia (2006).
Silva et al. (2019)	The limitations of this study are related to the sample period and a possible bias conferred by the Brazilian context.	It is suggested that future works extend the analyzed period, use international data in order to corroborate or refute the findings of this research, test the allocative efficiency of funds separately and together with operational efficiency, with a view to building a theoretical framework in the study of the efficiency of pension funds.
Arefjevs (2017)	Bancassurance is developed in illustration in the field of pension fund management, which is subject to research assumptions and limitations .	Regression and correlation analysis is applied to examine the relationship between variables describing the size and scope of operations and variables describing efficiency. In addition, pension fund management companies are classified in terms of the size and scope of their operations, using cluster analysis. Checks of the scored efficiency produced by different models are performed using a regression analysis. Finally, the fourth stage of the research is dedicated to the discussion and development of the results of recommendations in the research topic.
Garcia (2010)	The main limitation of this research is that the increase in competition resulting from the change in the regulatory environment undoubtedly increases the efficiency of the units operating in the market. However, this policy is not sufficient by itself to induce improvements in technology change. More investigations are needed to address the mentioned limitations.	First, the worst performing pension fund management companies should change their managerial procedures to adopt an efficient policy of enhanced incentives, which would allow these inefficient fund management companies to reach the efficient frontier. Second, adjustment must be based on improving technical efficiency as well as technological change.
De la Torre-Torres; Galeana-Figueroa; Álvarez-García (2019)	Even though the results do not provide strong short-term evidence for the use of a socially responsible investment strategy in the most aggressive pension funds, it does appear that the benefits will be seen in the long term, due to better performance during periods of distress and to the effect of delayed actions on performance.	The recommendation is for policy makers (both Mexican and international (savings authorities)): Given the results, we suggest promoting an ISR-only strategy in the public Sustainability, some Mexican pension funds due to the fact that even if we found an underperforming investment strategy, this underperformance is short-term, and in the long term, the benefits of investing in ISR companies are not just for savers, but for your entire economy. This suggestion occurs because IRS companies could have market prices or lower credit rates as incentives to improve the environmental and social impact of their activities.
Clark (2008)	The major limitation of the research was to restrict the successful cases to 4 patterns.	Link funds considered with good governance policy with geopolitical factors of their influence.
Lu et al. (2021)	The study was limited to Taiwan pension funds.	Future studies may adopt the innovative application of both DEA and raw set theory or other types of fuzzy sets to analyze the investment performance of companies in the financial sector.
Santos of Paula and Iquiapaza (2022)	One of the limitations of this research refers to the adoption of only seven techniques (three indicators) for selecting investment funds. Thus, for the construction of portfolios each semester, the other indicators presented could also be analyzed.	The study can be reapplied considering different periodicities in the data series, reaffirming the results found for monthly series.

(Table 6 continued)

Erzurumlu and Ucardag (2021)	Overlapping periods of regulatory change can complicate the ability to distinguish the impact of any specific change. The results, therefore, cannot be generalized to differently structured markets.	It did not present a research recommendation.
Xu et al. (2020)	The limitations of this study relate to first, because this study does not use detailed data for the composition of public pension boards, it does not carry out additional tests involving, for example, the effects of various attributes of assets and retired board members on the performance of boards. public defined benefit pension plans. Second, due to a similar lack of data on the educational background and financial experience of individual board members, only a dummy variable was employed in the research models indicating the presence or absence of such board experience, rather than comparing expertise across all boards. the areas.	A worthwhile avenue for future research would be to explore the effects on the performance of public defined benefit pension plans of such aspects of board member capital as education, experience, gender, relationships with other board members, and the training process.
Costa, Santos and Silveira (2014)	A dynamic optimization process was not used, scenarios were constructed with the objective of comparison. There was no step-by-step construction of portfolios considered optimal.	Perhaps indicating this step by step of the portfolio considered optimal is an opportunity to research different economic scenarios.
Gokgöz (2010)	Financial constraints or imperfectly competitive markets, in which case increasing inputs does not result in a proportionate increase in outputs.	There is clear evidence that the DEA method is a valuable tool for institutional and individual investors in analyzing the efficiency of funds in emerging markets such as the Turkish capital markets.
Andreu, Sarto and Vicente (2014)	The results found support the notion that academics and practitioners should apply SBM Variation III in concentrated industries.	The paper also provides evidence that higher levels of management capabilities represented by pension company size are not associated with a better strategic investment style.

4. Final Considerations

This literature review aimed to identify patterns of analysis of pension funds regarding their efficiency, the forms of evaluation defined by research, compare the efficiency of different types of methods and verify what types of results have been found in the evaluation of funds. Pension fund efficiency assessment is a largely unexplored area in academic research, the number of articles on the subject is scarce, the variability of research methods and objectives also vary. This aspect, despite being worrying from the point of view of social information, denotes that the topic is still being discussed in a very incipient way and that it can possibly be deepened by other studies with different approaches.

The studies propose to analyze the efficiency of pension funds from different perspectives, but the main variables of interest are the value of the fund's assets and the resources transferred to the associated beneficiaries. Efficiency measurement is quite peculiar in different countries, some measure efficiency according to the degree of adherence of the fund to the legislation of the current country, while others measure efficiency according to the asset purchase policy by the fund managers. The fact is that there is no more accepted way of measuring it, due to different peculiarities between countries, demographic indexes, local legislation, investment policies, among others.

Compensatorily, research has used data envelopment analysis (DEA) to fulfill the research objective. Despite being the most used methodology for this purpose, it is not unique. Other ways of measuring efficiency are used to

determine how efficient the management of these funds is being, as an example of this are the examples of research using the Malmquist productivity index, Sharpe Index, Data analysis in panel, Markowitz portfolio theory, Slack-based efficiency measure. The interaction between already established methods also seems to be a good alternative in the evaluation of efficiency, since, with this, the researches are able to evaluate the fund from different perspectives.

With regard to the results, the surveys are competent in what they propose. However, the plurality of perspectives of research objectives seeking to measure efficiency from the most diverse angles make the results analogous or incomparable. This makes it difficult to establish a common view on different scenarios. Another difficulty found in the limitations of the research is related to the unavailability of data, the period of the sample, regulatory changes in the countries, performance of the fund, among others. Which indicates, once again, that research on the efficiency of pension funds must be deepened in order to create a measurement and comparison parameter for members and intended consumers of the funds.

The present study has some limitations. The first refers to the number of articles researched on the subject of efficiency in pension funds, this was the first indication that there is a large gap in the literature that needs to be deepened. Secondly, the exclusion of unavailable texts during the search, because although few, they could expand the research data and, however, such documents were no longer included because they were not published even in versions of events or articles under discussion. As a proposal for the development of this work, we identified that the Data Envelopment Analysis - DEA is an excellent tool to evaluate the efficiency of funds, including the statistical relevance of interdependence. Applying DEA in two stages and then ranking the Sharpe index for the Brazilian reality, we intend to create a form of evaluation that is efficient for the Brazilian context.

References

Andreu L., Sarto J. L. and Vicente L. (2014). "Efficiency of the strategic style of pension funds: An application of the variants of the slacks-based measure in DEA", *Journal of the Operational Research Society*, Vol. 65, pp. 1886-1895, doi: https://doi.org/10.1057/jors.2013.74.

Arefjevs I. (2017). "Efficiency assessment concept model for financial alliances: Bancassurance in Baltic pension fund management", *European Integration Studies*, Vol. 11, No. 1, pp. 186-198, doi: https://doi.org/10.5755/j01.eis.0.11.18245.

Beltrão K. I., Leme F. P., Mendonça J. L. D. O. and Sugahara S. (2004). "Análise da estrutura da previdência privada brasileira: evolução do aparato legal", *Texto para Discussão IPEA*, Vol. 1043, pp. 1-30.

Bertín H. D. and Perrotto A. M. (1998). *Los nuevos Sistemas de pensiones en América Latina: Argentina, Bolivia, Chile, Colombia, Costa Rica, El Salvador, México, Perú y Uruguay*, Parte II. La Ley, pp. 152-244.

Clark G. L. (2008). "Governing finance: Global imperatives and the challenge of reconciling community representation with expertise", *Economic Geography*, Vol. 84, No. 3, pp. 281-302, doi: 10.1111/j.1944-8287.2008.tb00366.x.

Costa P. R. and Soares T. C. (2017). "A demanda por previdência privada no Brasil: uma análise empírica", *Textos de Economia*, Vol. 20, No. 1, pp. 36-50, doi: 10.5007/2175-8085.2017v20n1p36/.

Costa T. D. M. T., dos Santos M. L. and Silveira S. D. F. R. (2014). "Use of Ibovespa future contracts for pension funds in Brazil: A sectorial approach/Utilização de contratos futuros do Ibovespa em carteiras de fundos de pensão no Brasil: uma abordagem setorial", *Revista de Ciencias da Administracao*, pp. 110-126, doi: http://dx.doi.org/10.5007/2175-8077.2014v16n38p110.

Da Silva L. D. P. S. and de Oliveira M. R. G. (2011). "A regulação, diversificação e investimentos no exterior impactam na eficiência da gestão dos investimentos dos fundos de pensão brasileiros sob a ótica da teoria do portfólio", *BBR-Brazilian Business Review*, Vol. 8, No. 4, pp. 94-123.

Da Silva V. D. S., Pimenta K. K. P., Belli-marcio M. M., Junior J. H. P. and de Campinas E. (2019). "Determinantes da eficiência dos fundos de pensão: Uma análise operacional das Empresas Fechadas de Previdência Complementar (EFPC) no Brasil em 2015-2016", in: *XLIII Encontro da ANPAD - EnANPAD*.

De Almeida F. A. F., Seibert R. M., Wbatuba B. B. R., Salla N. M. D. C. G. and Both B. (2017). "Transparência dos Fundos de Pensão no Brasil: Um Estudo Exploratório", *Razão Contábil e Finanças*, Vol. 8, No. 2.

De Conti B. (2016). "Os fundos brasileiros de previdência complementar: segmentações analíticas e estudos preliminares sobre a alocação de seus recursos (No. 2175)", Instituto de Pesquisa Econômica Aplicada-IPEA.

De la Torre-Torres O. V., Galeana-Figueroa E. and Álvarez-García J. (2018). "Efficiency of the public pensions funds on the socially responsible equities of Mexico", *Sustainability*, Vol. 11, No. 1, p. 178, doi: https://doi.org/10.3390/su11010178.

Dietrich J. and Braido G. M. (2016). "Planejamento Financeiro Pessoal para Aposentadoria: um estudo com alunos dos cursos de especialização de uma instituição de ensino superior", *Sociedade, Contabilidade e Gestão*, Vol. 11, No. 2.

Diniz J. A. and Corrar L. J. (2017). "Avaliação da eficiência financeira de entidades fechadas de previdência complementar no Brasil", *Sociedade, Contabilidade e Gestão*, Vol. 12, No. 3.

Diniz M. M. (2016). "Cálculo de fluxo de caixa atuarial para planos de previdência do tipo benefício definido (Trabalho de Conclusão de Curso, Universidade Federal da Paraíba)", available online at: https://repositorio.ufpb.br/jspui/handle/123456789/3790.

Erzurumlu Y. O. and Ucardag I. (2021). „Private pension fund flow, performance and cost relationship under frequent regulatory change", *Journal of Financial Regulation and Compliance*, Vol. 29, No. 2, pp. 218-234, doi: https://doi.org/10.1108/JFRC-03-2020-0028.

Garcia M. T. M. (2010). "Efficiency evaluation of the Portuguese pension funds management companies", *Journal of International Financial Markets, Institutions and Money*, Vol. 20, No. 3, pp. 259-266, doi: https://doi.org/10.1016/j.intfin.2010.03.003.

Gökgöz F. (2010). "Measuring the financial efficiencies and performances of Turkish funds", *Acta Oeconomica*, Vol. 60, No. 3, pp. 295-320, doi: https://doi.org/10.1556/aoecon.60.2010.3.4.

Greenacre M. (2016). *Correspondence Analysis in Practice* (3rd ed.), Chapman and Hall/CRC, doi: https://doi.org/10.1201/9781315369983.

Lavinas L. and Araújo E. D. (2017). "Reforma da previdência e regime complementar", *Brazilian Journal of Political Economy*, Vol. 37, pp. 615-635.

Lima S. D. and Diniz J. A. (2016). *Contabilidade pública: análise financeira governamental*, São Paulo: Atlas, p. 576.

Lu W. M., Kweh Q. L. and Wang C. W. (2021). "Integration and application of rough sets and data envelopment analysis for assessments of the investment trusts industry", *Annals of Operations Research*, Vol. 296, pp. 163-194, doi: https://doi.org/10.1007/s10479-019-03233-y.

Macias-Chapula C. A. (1998). "O papel da informetria e da cienciometria e sua perspectiva nacional e internacional", *Ciência da informação*, Vol. 27, No. 2, pp. 134-140, doi: https://doi.org/10.1590/S0100-19651998000200005.

Nese A. D. A. S. (2017). "Governança, características das organizações e desempenho dos investimentos: evidências em fundos de pensão no Brasil", doctoral dissertation, Universidade de São Paulo, doi: https://doi.org/10.11606/T.12.2017.tde-13062017-162106.

Oliveira F. E. B. D. and Beltrão K. I. (2000). "The Brazilian social security system".

Paula J. S. D. and Iquiapaza R. A. (2022). "Investment fund selection techniques from the perspective of Brazilian pension funds", *Revista Contabilidade & Finanças*, Vol. 33, No. 88, pp. 167-182, doi: https://doi.org/10.1590/1808-057x202113250.

Roever L. (2017). "Compreendendo os estudos de revisão sistemática", *Revista da Sociedade Brasileira de Clínica Médica*, Vol. 15, No. 2, pp. 127-130.

Rogieri N. (1998). "Reforma da Previdência e os Fundos de Pensão", *Conjuntura Social*, Vol. 9, No. 3, p. 90.

Sass S. A. (1997). *The Promise of Private Pensions*, Cambridge MA: Harvard.

Siddiqui S. A. (2022). "How efficient is Indian health insurance sector: An SBM-DEA study", *Managerial and Decision Economics*, Vol. 43, No. 4, pp. 950-962, doi: https://doi.org/10.1002/mde.3430.

Thomas A., Spataro L. and Mathew N. (2014). "Pension funds and stock market volatility: An empirical analysis of OECD countries", *Journal of Financial Stability*, Vol. 11, pp. 92-103, doi: https://doi.org/10.1016/j.jfs.2014.01.001.

Winklevoss H. E. (1993). *Pension Mathematics With Numerical Illustrations*, University of Pennsylvania Press.

Xu G., Liu F. C., Hsu H. T. and Lin J. W. (2020). "The impact of pension governance practices on the public defined benefit pension performance", *Benchmarking: An International Journal*, Vol. 27, No. 1, pp. 192-214, doi: https://doi.org/10.1108/BIJ-08-2018-0265.