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GİRDİSİZ VERİ ZARFLAMA ANALİZİ YÖNTEMİ İLE İSLAMİ VE KONVANSİYONEL FONLARIN KARŞILAŞTIRMALI ANALİZİ[a]

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ÖZ

İslami fonlar, inanç temelli etik yatırımın temel bileşenlerinden biri olarak, faiz içeren işlemleri yasaklayan ve alkol, kumar ve silah üretimi gibi sektörleri yatırım alanı dışında bırakan İslami finans ilkeleri çerçevesinde faaliyet göstermektedir. Sermayenin sosyal ve ahlaki açıdan uygun görülen alanlara yönlendirilmesi yoluyla bu fonlar, finansal getirileri etik ve dini ilkelerle uyumlu hâle getirmeyi amaçlamaktadır. Bu çalışma, Türkiye'de faaliyet gösteren katılım (İslami) emeklilik fonlarının performans sonuçlarının geleneksel, faiz temelli emeklilik fonlarından farklılık gösterip göstermediğini incelemektedir. Ampirik analiz, 105 katılım emeklilik fonu ile bunlara eşit sayıda, yani 105 geleneksel fon içeren bir veri setine dayanmaktadır. Fon etkinliği, açık girdilerin kullanılmadığı bir model çerçevesinde, Alfa, Sharpe, Bilgi ve Sortino oranları gibi risk düzeltilmiş performans göstergelerinin çıktı olarak kullanıldığı veri zarflama analizi yöntemiyle değerlendirilmiştir. Bulgular, ortalama olarak katılım emeklilik fonlarının geleneksel fonlara göre biraz daha yüksek etkinlik skorlarına sahip olduğunu ortaya koymaktadır. Bu sonuç, İslami finans ilkelerine bağlılığın fon performansını olumsuz etkilemediğini göstermektedir.

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DATA ENVELOPMENT ANALYSIS BASED COMPARISON OF ISLAMIC AND CONVENTIONAL FUNDS WITHOUT EXPLICIT INPUTS[a]

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ABSTRACT

Islamic funds, as a central component of faith-based ethical investment, operate under Islamic financial principles that prohibit interest-bearing transactions and exclude sectors such as alcohol, gambling, and weapons manufacturing. Such funds aim to harmonize financial returns with ethical and religious principles by channelling resources toward activities considered socially and morally acceptable. This study examines whether Islamic (Participation) pension funds deliver performance outcomes that differ from those of conventional, interest-based pension funds in Türkiye. The empirical analysis draws on a dataset consisting of 105 participation pension funds and an equivalent sample of 105 conventional funds. Fund efficiency is assessed using a data envelopment analysis framework that employs risk-adjusted performance indicators (Alpha, Sharpe, Information, and Sortino ratios) as output variables in a model formulated without explicit inputs. The results indicate that participation pension funds exhibit, on average, slightly higher efficiency than their interest-based counterparts. This finding suggests that adherence to Islamic financial principles does not hinder fund performance.

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INTRODUCTION

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Islamic (Participation) funds operate within a framework shaped by Islamic finance principles, which are supervised by advisory boards with relevant expertise. In accordance with these principles, funds refrain from investing in firms that do not appear in participation indices, and equity selections are limited to companies that have received the approval of the advisory committee. The use of derivative instruments is either excluded altogether or restricted to hedging purposes, while leverage-based strategies and forward foreign-exchange contracts are expressly prohibited. Consequently, the portfolios of Islamic funds are generally composed of participation index equities, participation accounts denominated in local currency or gold, sukuk issued by sovereign or private entities, and, when specifically authorized by the advisory board, instruments such as real estate certificates, venture capital fund units, or precious metals. By adhering to these constraints, Islamic (Participation) funds position themselves as faith-aligned, ethically oriented investment vehicles that aim to ensure religious compliance while limiting exposure to excessive uncertainty and speculative risk.

Pension system enables individuals to accumulate long-term savings throughout their working lives, thereby supporting their retirement income and contributing to the development of domestic capital markets (Law No. 4632 on the Private Pension System-Türkiye 2001). The scale of the system’s recent expansion is evident in transaction data: the average daily trading volume of pension funds increased from 3,010,343.36 Turkish Lira (TL) in early January 2022 to 44,527,501.59 TL in the same week of 2023. By the first week of January 2024, this figure had climbed to 119,418,104.78 TL, illustrating the accelerated growth in market participation (TEFAS Reports, 2024).

Against this background, the study investigates whether participation in pension funds delivers performance outcomes comparable to or exceeding those of interest-based pension funds. The empirical analysis encompasses all 105 participation pension funds currently operating in the market, together with a control group of 105 conventional funds selected through random sampling to ensure a symmetric comparative framework. Fund efficiency is assessed using data envelopment analysis, employing a specification that omits explicit input variables and instead relies on performance-based outputs. The evaluation incorporates standard risk-adjusted performance indicators, "Alpha, Sharpe, Information, and Sortino ratios," which serve as the model's output variables. This output-oriented structure is designed to capture the extent to which each fund can maximize its performance metrics relative to its peers. The findings ultimately contribute to the broader discussion on whether participation in pension funds, grounded in religious and ethical investment norms, can attain efficiency levels that are competitive with those of conventional pension funds.

LITERATURE REVIEW

One of the early applications of data envelopment analysis (DEA) to mutual fund performance is the study by Murthi, Choi, and Desai (1997), who evaluated 2,083 mutual funds. Their model utilized the expense ratio, turnover rate, commission costs, and standard deviation as inputs, with the residual return serving as the single output variable. This study introduced the DEA portfolio index, which later became a reference point in performance measurement research. Another foundational contribution came from Fernández-Castro and Smith (1994), who presented one of the first DEA models designed without explicit input variables. Following this line of research, Liu et al. (2011) argued that DEA without explicit inputs offers a practical and efficient alternative, particularly when input data are either missing or conceptually unnecessary.

The study by Basso and Funari (2001) is widely referenced in the literature on DEA applications to mutual fund performance. They analysed 50 Italian mutual funds using DEA, treating standard deviation, beta, and fund expenses as input variables, and average returns, traditional performance measures, and stochastic indicators as outputs. Their results demonstrated that DEA complements conventional evaluation methods and is particularly useful for assessing ethical or socially responsible funds, highlighting its capability to account for non-financial objectives.

Building on this approach, Basso and Funari (2014) applied DEA to European socially responsible investment (SRI) equity funds. They examined both constant returns to scale (CRS) and variable returns to scale (VRS) models, testing for returns to scale and exploring how ethical objectives influence fund performance. The study also assessed the degree of social responsibility across SRI funds in multiple European countries. By applying DEA models that explicitly incorporate ethical criteria, the authors provided a detailed perspective on fund efficiency. Furthermore, their analysis revealed that pursuing ethical investment goals does not compromise financial performance, indicating that SRI funds can achieve both social responsibility and competitive returns.

Recent studies continue to highlight the usefulness of data envelopment analysis in assessing the efficiency of ethical and Islamic funds. Arif, Samim, Khurshid, and Ali (2019) found that Islamic mutual funds achieved higher average efficiency scores compared to conventional funds. Similarly, Abate, Basile, and Ferrari (2021) examined 634 European mutual funds and reported that those investing in ESG-compliant assets outperformed funds with weaker environmental, social, and governance engagement. In France, Shahrour (2022) applied DEA to evaluate both the financial and social performance of socially responsible mutual funds, demonstrating that

DEA can effectively integrate ethical criteria alongside financial returns, offering valuable insights for investors and fund managers.

Comparative research on ethical versus conventional funds has often focused on whether ethical restrictions influence performance. Bauer, Derwall, and Otten (2007) provide a notable example by analysing Canadian ethical mutual funds, assessing both performance and risk exposure, and concluding that ethical funds neither underperform nor outperform conventional funds significantly. Similarly, Fernandez-Izquierdo and Matallin-Saez (2011) studied Spanish ethical mutual funds using style analysis and multifactor regression, complemented with a bootstrap approach to compare homogeneous subsamples. Their findings show no significant performance differences between ethical and conventional funds, and in some cases, ethical funds perform even better. These results indicate that adherence to ethical investment criteria does not compromise financial returns and can coexist with competitive performance outcomes.

The financial performance of socially responsible investment funds has been a central topic of research due to concerns that investors may sacrifice returns by integrating ethical, social, and environmental considerations into their investment decisions. Both Australian and international studies have reported mixed results, often limited by methodological issues such as small sample sizes, varying time frames, and differing performance measurement models. In this context, Jones, van der Laan, Frost, and colleagues (2008) examined the return performance of 89 Australian ethical funds over the period from 1986 to 2005. Employing a multifactor CAPM model, which controls for size, book-to-market value, and momentum (Fama & French, 1996), the study found that ethical funds underperformed the market, particularly in the last five years of the sample (2000–2005). Risk-adjusted returns measured by Jensen’s alpha indicated an average annual underperformance of approximately 1.52% during 2000–2005 and 0.88% across the full sample period. These findings contrast with many earlier studies that reported no statistically significant differences between ethical and conventional funds, highlighting the importance of rigorous methodological design in assessing SRI performance.

Harry Markowitz’s study, "Portfolio Selection" (1952), frames investment decisions as an optimization problem that balances expected return and risk. Building on this foundation, the present portfolio design incorporates an additional dimension by integrating an ethical score into the investor’s utility function. A similar approach was adopted by Simister and Whittle (2013), who introduced ethical ratings into the utility formulation. In their analysis, ethical values provided by the Ethical Consumer Research Association were employed, ranging from 0 to 15, where “0” represents the lowest ethical assessment and "15" the highest (Simister & Whittle, 2013: 150).

The landscape of ethical investment has broadened significantly in recent years, now encompassing categories such as socially responsible investment, ESG-focused strategies, sustainability-oriented portfolios, impact-driven investment practices, and faith-based financial products (Corporate Finance Institute, 2022). Participation funds constitute an integral component of this wider ethical investment domain. These funds generate income by trading permissible assets using investor-supplied participation shares, and the earnings derived from the compliant securities within the portfolio are fully incorporated into the fund's net value.

In the context of Türkiye, several studies have examined the efficiency and performance of pension funds. Bayraktar and Aksoy (2020) evaluated participation pension funds using Alpha, Sharpe, Treynor, M^2, and T-ratios, finding significant performance differences among gold-based and lease certificate participation funds, as well as across risk categories. In another study, Küçükkıralı and Aydın (2022) applied DEA to analyse both operational efficiency and fund management efficiency across fifteen pension companies. Their findings indicated an average operational efficiency of 64% and an average fund management efficiency of 94%, revealing notable variation in the sector's overall effectiveness.

In Türkiye, pension fund classifications are defined in the guide issued by the Capital Markets Board. Fund names are determined according to the composition of their underlying assets. The guide describes several categories, including stock funds, debt instrument funds, participation funds, mixed funds, money market funds, precious metals funds, index funds, fund-of-funds structures, contribution funds, variable funds, and life-cycle funds (CMB Pension Investment Funds Guide, 2023). Among these, participation funds are distinguished by their commitment to internationally recognized principles of interest-free finance. These principles prohibit investment in sectors considered impermissible, such as interest-bearing financial activities, alcohol, gambling, and speculative trading.

Participation funds operate under the oversight of an advisory committee that reviews and approves investment decisions to ensure that all assets and transactions adhere to Islamic guidelines. The principles shaping these funds encourage long-term investing, promote risk-sharing, and discourage excessive uncertainty or leverage. Consistent with this long-term orientation, many participation funds allocate substantial portions of their portfolios to sukuk, the Islamic equivalent of bonds. Sukuk instruments provide steady income streams while remaining fully compliant with Islamic financial principles. Overall, these features position participation funds as a key component of faith-based and ethically aligned investment strategies in the pension system.

According to the Capital Markets Board decision dated 24.09.2020 (60/1183), equities included in the portfolios of funds carrying the term “participation” in their titles must be selected from indices approved as compliant with participation finance principles, such as the Participation 30 Index, Participation 50 Index, and Ziraat Portfolio Participation Index. These assets must also receive approval from an advisory board. The same compliance requirement applies to money and capital market instruments other than participation accounts, gold or precious metals, and promise-based contracts. Only instruments deemed suitable under participation finance principles may be included in the portfolios of such funds.

If a fund obtains advisory support, certain information must be made available. Details about the structure of the advisory board should be shared. The qualifications and experience of the board members in participation finance must also be stated. In addition, the way the board operates needs to be explained. The methods used to review and confirm compliance are required to be disclosed as well. These details are provided either in the annex of the fund prospectuses or on the fund’s public disclosure platform page. In addition, fund prospectuses that carry the term “participation” replace the phrase “leverage-creating transaction risk” with “participation-based transaction risk," accompanied by the necessary explanatory notes. These regulatory requirements aim to maintain transparency and ensure that participation funds operate within the ethical and religious boundaries of participation finance.

Participation funds are investment instruments approved by the advisory boards of pension companies and clearly marked as "participation" funds in their titles (Pension Monitoring Center, 2021). These funds aim to serve investors who prefer to allocate their savings in line with Islamic finance rules, making them an important element of ethical investment practices. In this study, the performance of participation pension funds in Türkiye is examined within this ethical finance perspective by comparing them with conventional, interest-based pension funds. The analysis is based on the expectation that the two fund groups may exhibit similar or different average efficiency levels. The null hypothesis assumes no difference, while the alternative hypothesis suggests that a distinction may exist. For this purpose, the study employs total risk–based performance indicators, such as the Sharpe and Sortino ratios, as well as systematic risk measures, including Jensen's alpha. Evaluating whether pension funds achieve competitive performance is relevant for both individual investors and the functioning of the pension system. In this context, data envelopment analysis offers a useful non-parametric method for identifying efficient funds under multiple performance criteria. The comparison aims to reveal whether participation-based pension funds exhibit lower performance relative to interest-based funds.

METHODOLOGY

The analytical foundations of efficiency measurement originate from Farrell's pioneering contribution in 1957, which established the conceptual basis for evaluating productive performance. Subsequent advancements by Charnes, Cooper, and Rhodes in 1978 transformed this foundation into what is now recognized as the modern DEA framework. Their formulation, known as the CCR model, introduced the assumption of constant returns to scale.

In DEA, overall efficiency is understood as a combination of technical efficiency and scale efficiency. The CCR specification measures comprehensive efficiency under the premise that production technologies exhibit constant returns to scale.

A unit is regarded as fully efficient only when it attains both technical and scale efficiency. These two components together determine total efficiency, which can be represented as:

Total Efficiency = Technical Efficiency × Scale Efficiency

Technical efficiency reflects whether a unit operates directly on the boundary of the feasible production set, and any deviation beneath this boundary signals inefficiency from a technological standpoint.

Scale efficiency, in contrast, concerns the extent to which a unit functions at an optimal operational size while remaining on the production frontier, thereby indicating proximity to the most advantageous scale of production.

This study follows an empirical approach consistent with earlier research on efficiency measurement. The analysis uses efficiency scores and output-based ratios. It does not define specific input variables. Even so, this method is supported by theory and has been applied in practice. Previous studies show that DEA models can still operate effectively without input data. This has been demonstrated in several works, including those by Liu et al. (2011) and Pastor et al. (2002).

Data envelopment analysis is a process of comparing the efficiency of decision-making units. The mathematical formula for data envelopment analysis is the weighted sum of outputs divided by the weighted sum of inputs. The mathematical formula of data envelopment analysis is calculated with the formula:

$$E = \frac{u_1 y_1 + u_2 y_2 + \cdots + u_n y_n}{v_1 x_1 + v_2 x_2 + \cdots + v_n x_m}$$

In this structure, the numerator reflects the weighted sum of all outputs, where each output $y_n$is multiplied by its corresponding weight u_n, signifying the relative importance assigned to that performance measure. The denominator represents the weighted sum of all inputs, with each input x_m multiplied by its associated weight v_m. The parameters n and m refer to the number of outputs and inputs included in the model, respectively. While the weights u_n and v_m are not predetermined; they are determined endogenously by the DEA algorithm to maximize the efficiency score of each decision-making unit under evaluation. In this way, the formulation provides a ratio that captures how effectively a unit transforms its inputs into outputs, forming the basis for comparing relative efficiency across all units within the dataset.

DEA is an analysis method based on mathematical programming that does not require weighting inputs and outputs. According to the program, inactive decision units receive a value between “0 and 1”, while active units receive a value of 1. Decision units with efficiency values equal to 1 form the best observation set. The best observation set constitutes a reference for ineffective decision units (Kutlar and Bakırcı, 2018:185).

The DEA does not require normal distribution conditions. Therefore, DEA is a common analysis method. However, data envelopment analysis’s inputs and outputs should be consistent and homogeneous with each other (Zhu, J.:2015). In order to perform DEA, there must be a minimum number of decision-making units according to the input and output variables. Ramanathan stated that in the calculation, the number of decision units should be at least 2 or 3 times according to the sum of inputs and outputs. It is explained that the number of units should be more than the multiplication of input and output numbers (Ramanathan, 2003:174). Data envelopment analysis functions within many approaches. Profitability approach is a production function that aims to maximize the income of financial institutions and minimize their expenses and costs. Profitability approach differs from the production and intermediation approach, which is derived (Coelli et al., 1998:40).

DEA analysis is divided into three groups according to analysis orientations, which are divided into two models as fixed and variable return to scale: input, output oriented, and non-oriented. The model that measures the maximum amount of output that can be increased without any change in the input composition used is called output-oriented data envelopment analysis (Coelli et al., 1998:180).

The CCR (Charnes, Cooper, and Rhodes) model is a foundational approach in Data Envelopment Analysis used to evaluate the relative efficiency of decision-making units (DMUs). Efficiency in this model is defined as the ratio of weighted outputs to weighted inputs, with the objective of maximizing this ratio for each unit under assessment.

$$\max \theta = \frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}}$$

In the mathematical formulation, y_{rj} denotes the amount of output r produced by decision unit j, while x_{ij} represents the amount of input $i$consumed by the same unit. The indices j, r, and $i$correspond to decision units, outputs, and inputs, respectively, and $u_n$signifies the weight assigned to a particular output y_n. In cases where no observable input data are available, such as DEA applications without explicit inputs, a small constant is assigned uniformly across all units, allowing the model to concentrate entirely on optimizing weighted outputs. This structure enables a comparative evaluation of DMUs by assessing how effectively each unit transforms inputs into outputs relative to its peers.

In this study, a form of data envelopment analysis is used where no explicit input variables are defined, and the focus lies solely on expanding outputs. In these "input-free" DEA settings, the efficiency of each decision-making unit is evaluated by identifying how much its outputs can be increased under the weighting constraints shared by all units, rather than by reducing inputs that do not exist in the model. This structure is suitable for performance assessments in cases where inputs cannot be observed or meaningfully specified, while multiple output measures, such as risk-adjusted performance ratios, are available. Similar models have been discussed in earlier work, including the radial DEA framework without inputs introduced by Lovell et al. (1999) and the broader DEA-WEI approach described by

Liu (2011). In line with these studies, the present analysis applies an output-oriented DEA model to maximize Alpha, Sharpe, Information, and Sortino ratios and to compare the relative efficiency of pension funds. For this reason, the approach is classified as DEA without explicit input.

The ratio of weighted outputs to weighted inputs in the model is set so that it cannot exceed “1.” This follows the idea that the efficiency of any decision unit can reach, but not surpass, the value of “1.” The terms v_i and u_r act as implicit weights, since these values are not directly observed but generated through the model. When the function is solved separately for each decision unit, the resulting efficiency scores always fall between 0 and 1. The structure is a linear programming model that provides an optimal solution for every unit.

Data Collection Instruments and Performance Ratios

The evaluation of participation pension funds was conducted by benchmarking their performance against interest-based pension funds. The analysis focused on identifying which funds achieved stronger results according to four widely recognized performance metrics: Alpha, Sharpe, Sortino, and Information ratios. These ratios were selected because they offer a comprehensive view of risk-adjusted performance.

All data used in the study were obtained from the Private Pension Fund Trading Platform, ensuring consistency and comparability across funds. Each ratio was calculated on a monthly basis over a 36-month period, providing a reliable foundation for accurate performance measurement. By employing these indicators, the study aimed not only to rank the funds but also to understand how participation funds perform under ethical and interest-free investment constraints.

The Jensen performance measure, commonly referred to as Jensen's alpha, represents the constant term in the regression model that relates a fund's return to the return of its benchmark index (Jensen, 1968: 393). This metric evaluates whether a fund generates returns above or below what would be expected based on its systematic risk level. In other words, it helps determine whether a fund manager adds value beyond market movements after adjusting for risk. Jensen's alpha is calculated using the following formula:

$$\alpha = \bar{r}_i - [\bar{r}_f + \bar{\beta}_i (\bar{r}_b - \bar{r}_f)]$$

In this formulation, $\bar{r}_i$ represents the average return generated by fund i over the analysis period, reflecting its overall performance. The term $\bar{r}_f$ denotes the average risk-free rate, taken in this study as the BIST KYD O/N gross rate, which serves as a baseline return that carries no market risk. The beta coefficient $\bar{\beta}_i$, measures the sensitivity of fund "i" to movements in the benchmark index and captures the level of systematic risk undertaken by the fund. Finally, $\bar{r}_b$ refers to the average return of the benchmark, representing the broader market performance against which the fund is assessed. Together, these components make it possible to determine whether the fund delivers returns above or below what would be expected given its risk profile, thereby forming the basis of Jensen's alpha.

This measure reflects the fund's ability to outperform its expected return given its exposure to market risk. A positive alpha indicates superior managerial performance or effective asset selection, while a negative alpha implies underperformance relative to market expectations. Within the context of this study, Jensen's alpha serves as one of the core performance indicators for evaluating and comparing participation and interest-based pension funds.

The Sharpe ratio expresses a portfolio's return in relation to the risk it undertakes. It measures how much excess return a fund generates above the risk-free rate for each unit of total risk taken (Sharpe, 1966:122). The formula is:

$$S.R. = \frac{`r_i - `r_f}{\sigma_i}$$

The Sharpe ratio evaluates a fund's return relative to the level of risk it carries. In this formulation, the numerator represents the excess return generated by the fund, calculated as the difference between the fund's average return ($\bar{r}_i$) and the average risk-free rate ($\bar{r}_f$). This excess return reflects the additional compensation an investor receives for taking on risk beyond a risk-free investment. The denominator, the standard deviation of the fund's returns (σ_i), serves as a measure of total risk or volatility. By dividing excess return by volatility, the Sharpe ratio provides a standardized metric indicating how efficiently a fund converts risk into return. A higher ratio signals stronger risk-adjusted performance, allowing for meaningful comparison across funds with varying risk profiles.

Sortino ratio is like the Sharpe ratio. However, the Sharpe Ratio considers all upside and downside volatility, while the Sortino ratio only considers downside volatility. This risk measure is referred to as semi-volatility or loss-volatility. Sortino ratio shows the return earned per unit of partial volatility incurred (Sortino, 1994: 130). Sortino ratio is formulated as follows:

$$\text{SOR.R.} = \frac{\grave{}\mathrm{r_i} - \grave{}\mathrm{r_f}}{\sigma_D}$$

The Sortino ratio is a risk-adjusted performance measure developed to address the limitations of the traditional Sharpe ratio by focusing specifically on downside risk. Mathematically, it is expressed as the difference between the average return of a fund ($\bar{r}_i$) and the average risk-free rate ($\bar{r}_f$), divided by the fund's downside deviation (σ_D). Here,

$\bar{r}_i$ represents the expected return of the investment, reflecting the performance investors aim to achieve, while $\bar{r}_f$ typically corresponds to the returns of risk-free assets, such as government bonds, serving as a benchmark for evaluating excess returns. The denominator, σ_D, measures the volatility of returns that fall below a specified target or minimum acceptable return, capturing only negative deviations rather than total volatility. By focusing specifically on downside risk, the Sortino ratio delivers a more accurate evaluation of a fund's reward-to-risk characteristics. It highlights the influence of losses on investment performance and serves as a practical metric in contexts where safeguarding against negative returns is a central priority.

The Information ratio is calculated by dividing the value obtained after deducting the average return of the benchmark from the fund's average return by the fund's benchmark tracking error. It is formulated as:

$$\mathrm{I.R.} = \frac{(\grave{r}_i - \grave{r}_b)}{\sqrt{\frac{\sum_{t=1}^{n}\left((r_{i,t} - r_{b,t}) - \grave{}(r_{i,t} - \grave{r}_{b,t})\right)^2}{(n-1)}}}$$

The Information ratio is a widely used performance measure that evaluates a fund's ability to generate excess returns relative to a specified benchmark, considering the consistency of those returns. It is calculated by dividing the difference between the fund's average return ($\bar{r}_i$) and the benchmark's average return ($\bar{r}_b$) by the fund's benchmark tracking error, which measures the standard deviation of the active return. In this formulation, $r_{i,t}$ and $r_{b,t}$ represent the returns of the fund and the benchmark at time t, respectively, while $\bar{r}_{i,t}$ and $\bar{r}_{b,t}$ denote their respective average returns over the observation period. The parameter $n$corresponds to the total number of observations considered. By incorporating the variability of returns relative to the benchmark, the Information ratio captures not only the magnitude of excess returns but also their reliability over time, offering a comprehensive assessment of the fund manager's skill in consistently outperforming the benchmark. This measure is particularly valuable for investors seeking to evaluate performance in terms of risk-adjusted active management rather than absolute returns.

Procedure

The study examines participation pension funds within the structure of interest-free finance principles and the advisory board mechanisms that ensure compliance with Islamic finance principles. A total of 105 pension funds meeting the data requirements were included in the analysis. For comparative purposes, an equivalent set of 105 conventional, interest-based pension funds was randomly selected to create a balanced and methodologically sound comparison group.

To assess the performance of both fund categories, the study utilized four widely accepted risk-adjusted performance indicators: Alpha, Sharpe, Information, and Sortino ratios. These measures capture different aspects of return generation relative to risk, allowing for a multidimensional evaluation of fund performance.

The Kolmogorov–Smirnov test was applied to check whether the performance ratios followed a normal distribution. Since the performance scores did not meet the normality assumption, the Mann-Whitney U test was employed to examine whether there was a significant difference between the two fund groups.

Sample and Study Group

The study is based on a dataset covering a 36-month period from January 2021 to December 2023. Over this interval, monthly values were gathered for four performance indicators: Alpha, Sharpe, Information, and Sortino ratios. The sample consists of all 105 participation (interest-free) pension funds that meet the requirement of having data for the full 36 months. To create a comparable benchmark group, 105 conventional (interest-based) pension funds were randomly selected. The number of participation funds was not determined by preference; it represents the complete set of eligible funds with continuous data availability. All performance metrics were retrieved from the Private Pension Fund Trading Platform of Türkiye, calculated consistently for the same 36-month period. This sample group ensures comprehensive coverage of the participation-fund universe while enabling a meaningful comparison with conventional funds.

Model

In this study, the efficiency assessment of pension funds was conducted using Data Envelopment Analysis. The analysis adopted a framework commonly referred to in the literature as DEA without explicit input, which is particularly appropriate in settings where traditional input variables are either unobservable, conceptually irrelevant, or not required for the performance structure under examination. Instead of measurable inputs, a small, fixed constant value was assigned equally to all decision-making units.

The performance indicators used in the study “Alpha, Sharpe, Information, and Sortino Ratios” were incorporated into the DEA framework as output variables. The model was structured in an output-oriented manner, aiming to identify the extent to which each fund could maximize its performance under the constraint of the shared fixed input. This orientation is suitable for performance evaluation where the goal is to enhance output rather than reduce input.

These performance ratios were used as the output variable in the DEA model, and a constant input value of 0.0001 was assigned to every fund. For this reason, the approach is classified as DEA without explicit input. The analysis was conducted in an output-oriented framework, aiming to maximize the performance indicators.

Each fund in the sample was treated as a separate decision-making unit, and the DEA model was solved individually for all observations. The resulting efficiency scores range between “0 and 1”, consistent with the linear programming structure of DEA. These scores reflect the relative ability of each fund to achieve superior performance based on the selected risk-adjusted measures, allowing for a comprehensive comparison between participation and conventional pension funds.

FINDINGS

The performance of the pension funds was evaluated and ranked using data envelopment analysis. Initially, descriptive statistics for all performance measures were calculated and presented. The descriptive statistics table-1 summarizes key information, including sample sizes, mean values, skewness and kurtosis coefficients, and other relevant metrics for the pension funds.

Table 1: Descriptive Statistics of Pension Funds

Descriptive Statistics	Participation Pension Funds				Interest-Based Pension Funds			
	Alpha	Sharpe	Inf.	Sortino	Alpha	Sharpe	Inf.	Sortino
Ob. N.	105	105	105	105	105	105	105	105
Average	1.36	0.29	0.39	1.59	0.29	0.96	0.07	0.27
Median	0.55	0.3	0.46	1.45	0.07	0.96	0.05	0.07
Max.	5.19	0.84	0.84	5.83	2.61	1.77	0.53	3.15
Min.	-0.24	-0.26	-0.19	-0.21	-0.37	0.14	-0.37	-0.43
Standard Deviation	1.48	0.22	0.26	1.44	0.63	0.31	0.21	0.62
Skewness	0.81	-0.52	-0.58	0.97	2.21	0.08	0.23	2.36
Kurtosis	2.19	3.34	2.41	3.41	7.14	4.21	2.29	10.31
Prob.	0.00	0.07	0.02	0.00	0	0.04	0.21	0
T-Statistics	-7.08	-9.48	-6.46	-6.72	-8.08	-12.06	-8.98	-8.71

The Kolmogorov-Smirnov test was applied because the number of observations was n > 50. The normality analysis of Alpha, Sharpe, Information, and Sortino ratios of participation and interest-based pension funds was done by the Kolmogorov-Smirnov test.

Table 2: Statistical Analysis of Pension Funds

Performance Ratios	Participation Pension		Interest-Based Pension	
	Normality Test			
	Statistics Value	Probability Value (Sig.)	Statistics Value	Probability Value (Sig.)
Alpha R.	0.226	0.0	0.28	0.0
Sharpe R.	0.105	0.006	0.179	0.0
Information R.	0.126	0.0	0.065	0.2
Sortino R.	0.109	0.004	0.196	0.0

According to the Kolmogorov-Smirnov test conducted specifically for the participation funds, it has been determined that the probability values are less than 0.05 and the values of these performance criteria are not normally distributed. In the Kolmogorov–Smirnov test conducted on interest-based pension funds, it was determined that the probability values of the Alpha, Sharpe, and Sortino ratios were below 0.05, indicating that these performance ratios did not exhibit a normal distribution, whereas the Information Ratio was found to be normally distributed. Since most of the performance indicators did not demonstrate normality, parametric analytical methods were deemed unsuitable. Therefore, data envelopment analysis which does not require the assumption of normal distribution and is well suited for evaluating relative performance under such conditions, was employed to assess the efficiency of the funds.

Table 3: Efficiency Scores of Pension Funds

Participation Funds			Interest- Based Funds		
N.	Code	Efficiency	N.	Code	Efficiency
1	ACV	0.887	1	AE1	0.551
2	EEA	0.485	2	AE3	0.758
3	AER	0.576	3	AEG	0.403
4	AFP	0.857	4	AEH	0.596
5	AGA	0.489	5	AEY	0.565
6	AGB	0.523	6	AFH	1
7	AGD	0.511	7	AFJ	0.829

Participation Funds			Interest- Based Funds		
N.	Code	Efficiency	N.	Code	Efficiency
8	AGE	0.475	8	AG4	0.4
9	AGG	0.497	9	AH0	0.958
10	EVS	0.587	10	AH1	0.481
11	AGM	0.492	11	AH4	0.54
12	AGT	0.461	12	AH5	0.666
13	AIE	0.806	13	AH8	0.351
14	AIP	0.805	14	AHB	0.785
15	AJG	0.876	15	AHJ	0.996
16	AJH	0.886	16	AJA	1
17	AJY	0.907	17	AJB	1
18	AJZ	0.887	18	AJR	1
19	AO2	0.798	19	AJT	0.378
20	AVJ	0.969	20	ALJ	0.899
21	AYJ	0.808	21	ALZ	0.91
22	BEF	0.99	22	AMG	0.549
23	BEI	1	23	AMR	0.546
24	BEO	0.995	24	AMY	0.65
25	BNZ	0.749	25	AMZ	0.57
26	BPC	0.964	26	ANG	0.566
27	BPO	0.873	27	ANS	0.661
28	BPS	0.945	28	APG	0.448
29	CFE	0.874	29	ATE	0.628
30	CFC	0.826	30	ATK	0.526
31	CFY	0.744	31	AUG	0.554
32	CHD	1	32	AVE	0.823
33	CHI	0.929	33	AVG	0.526
34	FGH	0.852	34	AVN	0.699
35	FII	0.741	35	AVP	0.682

Participation Funds			Interest- Based Funds		
N.	Code	Efficiency	N.	Code	Efficiency
36	FIM	0.597	36	AVU	0.56
37	FIS	0.711	37	AVY	0.451
38	FIU	0.763	38	AZA	0.503
39	FIV	0.75	39	AZH	0.761
40	FIY	0.944	40	AZL	0.581
41	FYL	0.725	41	AZM	0.595
42	FYN	0.85	42	AZS	0.699
43	FYU	0.852	43	AZY	0.572
44	FYY	0.747	44	BPF	0.473
45	GCK	0.865	45	BPG	0.474
46	GDV	0.869	46	BPU	0.596
47	GEA	0.486	47	CGE	0.665
48	GES	0.527	48	CHM	1
49	GHA	0.496	49	CHN	0.605
50	GHL	0.651	50	EIF	0.562
51	GHU	0.863	51	EIG	0.437
52	GHV	0.699	52	EIK	0.588
53	GHY	0.864	53	EST	0.629
54	GHZ	0.744	54	FEA	0.469
55	HEA	0.498	55	FEI	0.541
56	HEE	0.496	56	FEN	0.597
57	HEG	0.745	57	FEO	0.826
58	HEI	0.828	58	FER	0.882
59	HER	0.667	59	FEZ	0.268
60	HHM	0.542	60	FGF	0.872
61	HHN	0.543	61	FIC	0.917
62	KEA	0.539	62	FIE	0.834
63	KEB	0.574	63	FIF	0.66

Participation Funds			Interest- Based Funds		
N.	Code	Efficiency	N.	Code	Efficiency
64	KED	0.877	64	GCS	0.896
65	KEF	0.515	65	GCV	1
66	KEG	0.646	66	GED	0.408
67	KEH	0.601	67	GEG	1
68	KEK	0.577	68	GEK	0.481
69	KES	1	69	GEU	0.607
70	KET	0.883	70	GHE	0.741
71	KEY	0.997	71	GHF	0.518
72	KEZ	0.956	72	GHG	0.537
73	KKS	0.444	73	GHH	0.58
74	KOS	0.825	74	GHM	1
75	KTZ	0.949	75	GHT	0.363
76	MHA	0.473	76	GKB	0.562
77	MHC	0.654	77	HED	0.571
78	MHI	0.725	78	HEP	0.575
79	MHS	0.482	79	HES	0.852
80	MHU	0.694	80	HET	0.541
81	MHV	0.728	81	HHG	0.562
82	NHC	1	82	HHY	0.445
83	NHH	0.961	83	HS1	0.506
84	NHK	0.851	84	IEA	0.523
85	NHR	0.97	85	IEB	0.575
86	NNK	1	86	IEG	0.421
87	PRC	0.632	87	IER	0.552
88	TKV	0.9	88	KOA	0.862
89	VEB	0.436	89	MHD	0.584
90	VED	0.892	90	MHL	0.57
91	VEO	0.799	91	MHN	0.884

Participation Funds			Interest- Based Funds		
N.	Code	Efficiency	N.	Code	Efficiency
92	VER	0.594	92	MHR	0.807
93	VEY	0.491	93	MHZ	0.934
94	VGA	0.499	94	NHM	0.308
95	VGB	0.493	95	PRS	0.763
96	VGD	0.341	96	VEE	0.675
97	VGG	0.723	97	VEI	0.574
98	VGH	0.775	98	VEP	0.77
99	VGK	0.874	99	VEU	0.4
100	VKE	0.909	100	VGF	0.873
101	VVU	0.836	101	VGY	0.664
102	VVZ	0.867	102	VKJ	1
103	VMU	0.69	103	VVA	0.897
104	ZHD	0.477	104	VVE	0.871
105	ZHF	0.527	105	ZHE	0.735
Avg.		0.734			0.658

To determine whether a statistically significant difference exists between the performance scores of participation and interest-based pension funds, the first step involved examining the normality of the efficiency score distributions. The Kolmogorov–Smirnov test was applied to both fund groups. As presented in Table 4, the probability values for participation funds (p = 0.001) and interest-based funds (p = 0.0) fall below the 0.05 significance level. These findings indicate that the efficiency scores of both fund categories deviate from a normal distribution.

Table 4: Normality Distribution Analysis of Efficiency Scores

Normality Distribution			
Fund Sample	Kolmogorov-Smirnov Test		
	Statistics	df.	Prob.
Participation Funds	0.12	105	0.001
Interest-based Funds	0.15	105	0.0

Since the efficiency score data do not satisfy the assumption of normality, the comparison between participation funds and interest-based funds was carried out using the Mann-Whitney U-test. This non-parametric method was applied to determine whether the average efficiency scores of the two fund groups differ significantly at the 0.05 confidence level.

As shown in Table 5, participation pension funds have a higher mean efficiency score (0.733) compared to interest-based funds (0.658), with similar standard deviations across both groups. The paired sample correlation between the two fund sets is low (0.092) and statistically insignificant (p = 0.35), indicating that the efficiency scores of the two categories are not strongly related.

The Mann-Whitney U-Test results reported in the same table show a significant p-value of 0.009, revealing a statistically meaningful difference between the two groups.

Table 5: Efficiency Scores of Pension Funds

Paired Instance Statistics				
Efficiency Score	Average Score	Observation Number	Standard Deviation	Standard Error Average
Participation F.	0.733	105	0.179	0.017
Interest-Based	0.658	105	0.189	0.018
Paired Sample Correlations				
Efficiency Score		Observation	Correlation	Prob.
Participation-Interest Based F.		105	0.092	0.35
Mann-Whitney U-Test Results				
Participation-Interest-based Pension Funds		Probability Value (Sig.)		
		0.009		

*0.05% confidence level.

When the Mann-Whitney U-test results were examined, the probability value was calculated as 0.009 and was found to be less than 0.05. Therefore, "H_0 There is no difference between the efficiency scores of the participation funds and the interest-based funds." was rejected. Alternative hypothesis " H_1 There is a difference between the efficiency scores of the participation pension funds and the interest-based pension funds." was accepted. As a result, it was detected that participation funds have a significantly higher performance than interest-based funds.

Two sample Kolmogorov-Smirnov tests were applied on the efficiency scores of the participation and interest-based pension funds, and

D=0.133 and p-value = 0.308 values were calculated. The test result p-value is greater than 0.05, and H_0 is in the acceptance range. As a result, it has been determined that participation and interest-based pension funds' efficiency scores come from the same main audience distribution. Among the participation pension funds, five effective funds have been identified. It was observed that 4.76 % of the sample was an effective fund, and the average efficiency score was 0.734. It was found that 9 out of 105 interest-based funds were effective funds, and 8.57 % of the sample was effective funds. It has been determined that the average efficiency score of the interest-based funds is 0.658. It has been found that the efficiency average of participation funds is higher than the efficiency average of interest-based funds.

Results

The findings of the analysis indicate that participation funds exhibit higher relative efficiency compared with their conventional, interest-based counterparts. This superior efficiency suggests that the investment framework governing participation funds, rooted in Islamic financial principles, does not hinder performance. As these funds operate within a faith-based structure that restricts speculative activities and emphasizes asset-backed, ethically aligned investments. The results, therefore, imply that adherence to participation finance principles can coexist with, and potentially enhance, competitive financial performance within the pension fund sector.

DISCUSSION

The study aims to assess the overall performance of the funds. This study examined the performance of pension funds by comparing 105 participation pension funds with 105 randomly selected interest-based pension funds, with in the Turkish pension fund market. Using data envelopment analysis, the average efficiency scores were calculated, revealing that participation pension funds achieved a score of 0.734, slightly higher than the 0.658 average of interest-based funds. These results indicate that participation pension funds, operating within the framework of ethical investment practices, do not suffer from performance disadvantages relative to their conventional counterparts. As a result, the findings support that participation in pension funds can achieve strong and comparable performance results.

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ARAŞTIRMACILARIN KATKI ORANI

Yazarların mevcut araştırmaya katkı oranları aşağıda belirtildiği gibidir:

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ETHICAL APPROVAL OF THE STUDY

All rules within the scope of “Instruction on Research and Publication Ethics for the Higher Education Institutions” were observed throughout the study. No actions mentioned in the Instruction’s second chapter titled “Actions Against to Scientific Research and Publication Ethics” were taken in the study.

PEER REVIEW

Reviewed by at least two external referees / Double-Blind Review.