

Optimal Portfolio Analysis of Private Pension Fund Investment in Indonesia: Markowitz Theory Approach (Efficient Frontier) and Single Index Model Theory

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Abstract

This study aims to determine the behavioral characteristics of private pension fund management institutions in Indonesia in making investment decisions in terms of risk aspects. In addition, this study also wants to test whether the current investment income is optimal and test whether there are differences in income levels from the three types of pension fund programs in Indonesia. The data used in this study are secondary data obtained from the Financial Services Authority (OJK). The data analysis techniques used are using the weighted average of investment risk, the application of Markowitz (Efficient Frontier) theory and SIM, especially the Treynor ratio, and non-parametric difference testing with the Mann-Whitney U Test and the Kruskal Wallis Test. The results of this study indicate that: First, the behavioral characteristics of investment decision-making of pension fund management institutions tend to avoid risk. Second, for the PPMP and PPIP pension fund programs, the optimal portfolio composition is 50% stocks with actual returns and 50% stocks with returns that take into account SIM, while for DPLK the optimal composition is 40% stocks with actual returns and 60% stocks with returns that take into account SIM. Third, in aggregate and individually for each investment instrument there are differences in returns on the three types of pension fund programs in Indonesia.

Keywords: Efficient Frontier, Portfolio Risk and Return, Single Index Model, Treynor Ratio

1. Introduction

Based on OJK's monthly statistical data in February 2024, there were 194 pension fund institutions in Indonesia. This number consists of 3 types of programs, namely Employer Pension Funds-Defined Benefit Pension Program (DPPK-PPMP), Employer Pension Funds-Defined Contribution Pension Program (DPPK-PPIP), and Financial Institution Pension Funds. With total assets of voluntary pension funds managed amounting to IDR 372.3 trillion in February 2024, this figure increased by 7.03% YoY compared to 2023.

The rate of return on investment (ROI) generated by the Joint Private Pension Fund in Indonesia from the investment fund allocation explained above is still lower than the interest rate on term deposits (12 months) of general banks in Indonesia during the last 5-year period (2019-2024). For more details, see the following graph.



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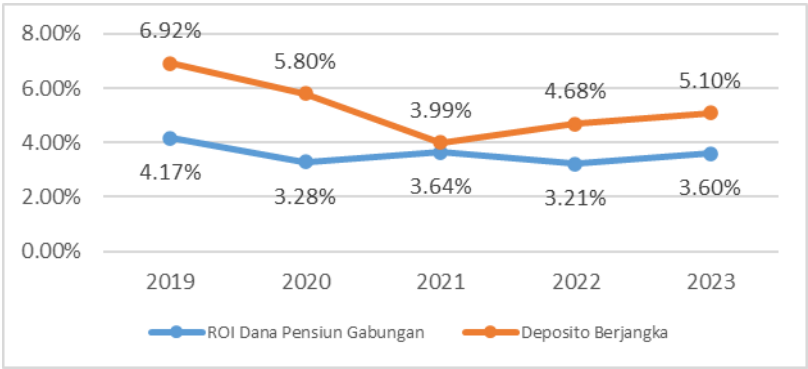


Figure 1.1.
ROI of Joint Pension Funds and Time Deposit Interest Rates in Indonesia (2019-2024)
Source: Indonesian Banking Statistics Data from OJK and Author's Processing

Based on the data above, it can be seen that the Return On Investment (ROI) of Joint Pension Funds in Indonesia is still lower than the interest rate on term deposits, this shows that the investment results of pension funds in Indonesia are still less than optimal because the returns are even lower than the deposit interest rates. This is the first problem that is the background for the author to conduct this research, it is hoped that with this research the return or yield from investment in joint private pension funds in Indonesia can be better and increase in the future. Furthermore, another problem faced by private pension fund institutions in Indonesia besides the low ROI from the investments made is the low interest and awareness of the public to prepare for their retirement by participating in a pension fund program. Quoted from an article on the website of the Financial Institution Pension Fund Association (DPLK) entitled "The Elderly Population is Increasing, Pension Funds Have Not Remembered" states that 7 out of 10 retirees in Indonesia experience financial problems, aka are economically helpless. Even from the survey conducted, it was stated that 1 in 2 retirees are still working and 9 out of 10 workers in Indonesia are not at all ready to enter retirement. This is in accordance with a survey conducted by Sun Life Asia in Indonesia and other Asian countries showing that 67% of respondents started planning for retirement funds within five years before retirement and 19% had no plans at all. In addition, the majority of respondents also only allocated 10% of their income for pension funds, while 27% of respondents did not allocate special funds for retirement. This is in line with data from the Pensions at A Glance report made by the international institution OECD which shows that the Net Pension Wealth of retirees in Indonesia is one of the lowest compared to other Asia Pacific countries. The Net Pension Wealth of retirees in Indonesia is 8.0 times the individual's net annual salary, on par with Sri Lanka and only greater than Pakistan which is the lowest at 6.1 times. For more details, see the table below.

Table 1.1.
Net Pension Wealth Asia Pacific 2024

	Individual earnings, multiple of mean							Individual earnings, multiple of mean					
	0.5		1.0		2			0.5		1.0		2	
	Men			Women				Men			Women		
East Asia/Pacific							OECD Asia/Pacific						
China	26.1	20.3	17.6	26.3	20.1	17.4	Australia	16.6	10.6	8.2	17.7	11.0	8.3
Hong Kong (China)	12.8	9.3	7.0	14.3	10.1	7.4	Canada	11.3	9.2	5.1	12.3	10.0	5.6
Indonesia	8.0	8.0	8.0	8.6	8.6	8.6	Japan	10.5	8.2	6.8	12.5	9.8	8.0
Malaysia	10.1	10.1	10.2	10.1	10.0	10.1	Korea	10.1	7.1	4.6	12.1	8.5	5.5
Philippines	13.9	13.3	14.2	15.8	15.1	16.2	New Zealand	16.1	10.7	5.8	17.4	11.6	6.3
Singapore	14.0	13.5	7.9	14.0	13.5	7.9	United States	11.5	9.5	7.4	12.2	10.2	7.9
Thailand	11.6	10.6	5.3	13.2	12.1	6.0	Other OECD						
Viet Nam	13.2	13.2	13.3	16.4	16.4	16.6	France	14.0	14.8	12.8	15.9	16.8	14.5
South Asia							Germany	13.1	12.3	9.6	14.6	13.6	10.6
India	9.1	9.1	5.2	9.6	9.6	5.2	Italy	13.3	14.2	15.0	15.1	16.0	17.0
Pakistan	12.3	6.1	3.1	14.6	7.3	3.6	United Kingdom	16.0	11.3	8.0	17.2	12.2	8.5
Sri Lanka	8.0	8.0	8.0	6.6	6.6	6.6	OECD	14.6	12.3	10.3	16.3	13.6	11.5

if added to the managed funds of BPJS Ketenagakerjaan in August 2024 reaches IDR 767.23 trillion. So if the total Public Pension Fund (BPJS) and Private Pension Fund (DPPK & DPLK) in Indonesia is added up, it reaches IDR 1,139.53 trillion, or around 5.15% of Indonesia's GDP. This amount is still very small, considering that to become a developed country, pension funds must reach 60% of GDP by 2045.

In addition, when viewed from the number of levels of participation of workers in pension fund programs in Indonesia, it is still much smaller than in other countries. In the monthly statistical data released by the OJK, in February 2024 the total number of combined private pension fund participants in Indonesia reached 4,273,119 people. With a proportion of DPPK-PPMP of 881,337 people (20.7%), DPPK-PPIP of 385,967 people (9.0%), and DPLK of 3,005,815 people (70.3%). Meanwhile, based on data from the IFG Progress Weekly Digest in November 2021, the coverage of the Pension Fund program in Indonesia (including BPJS) was only 16.4% of the total number of workers in Indonesia. This figure is still far below the average for Asian countries (21.27%) and also below neighboring countries such as Malaysia (31.3%), Thailand (28.3%), and the Philippines (22.2%). From all the conditions and problems that have been explained above, this is where the role of this research is expected to provide solutions to these problems. Therefore, the variables that will be studied are regarding the investment instruments used by private pension funds in investing, along with the proportion of each investment instrument that will ultimately form a portfolio. The decision to determine what type of investment instrument to choose will depend heavily on the behavior of private pension funds in investing, especially in viewing investment risk. Does their behavior tend to be risk-averse, neutral, or risk-lover? This study will examine this behavior, which then after the behavior is known, an analysis of the optimal portfolio composition will be carried out in order to produce good returns with maintained risk. Then it will also be examined whether there is a difference in returns on each type of program available at private pension funds in Indonesia. It is hoped that if there is no significant inequality and difference in returns, it can increase public interest in participating in pension fund programs, because people are no longer worried that in the future their money will be eroded by inflation or even reduced in the future. So that in the end, with the increasing participation of the community in the pension fund program, it is hoped that it can also contribute more to national development and accelerate Indonesia to become a developed country.

2. Method, Data, and Analysis

According to Sugiyono (2021), a dependent variable is a variable that experiences an impact or influence due to the presence of another variable, while an independent variable is a variable that influences or causes changes in the dependent variable. In this study, the dependent variables are the return and risk (standard deviation) of the formed investment portfolio. While the independent variables in this study are the proportion of each investment instrument that has been selected as a sample in this study.

According to Ferdinand (2013), population refers to a complete collection of elements, which can be people, objects, transactions, or events that are interesting to study. In this study, the population consists of all private pension funds in Indonesia whose entire managed funds and investment management are reported to the Financial Services Authority (OJK). For sampling from pension funds used in this study, all populations are taken as samples. However, for samples from investment instruments used in this study, the sampling technique is nonprobability with purposive sampling technique, which is a method of determining samples with special considerations, where sample members in this case the type of investment instrument used are selected as the largest and most significant influence on the overall investment results of managed funds.

Method of collecting data

According to Sugiyono (2016:2) quantitative research methods can be interpreted as research methods based on the philosophy of positivism, used to research certain populations or samples, data collection using quantitative/statistical data analysis research instruments. The data used in this study are secondary data. According to Edi Riadi (2016:48) secondary data is data obtained indirectly from the research object. Secondary data obtained is from an internet site, or from a reference that is the same as what is being researched by the author. The data to be used in this study is the Pension Fund Statistics Data published by the OJK every month on the official OJK website (www.ojk.go.id) in the period 2019-2023.

The data collection method used in this study is the documentation method. According to Sugiyono (2021), documentation is a recording of events that have occurred, which can be in the form of writing, pictures, or other forms. The documentation approach in this study involves collecting data from reports that have been processed by other parties, which are believed to be true because they come from the official website of the Financial Services Authority (OJK). In addition, this study also uses library research, where the author conducts searches and studies previous research along with previously used

theories and is supplemented with information from various literature sources to strengthen the theoretical basis in the discussion and analysis.

First Problem Formulation Analysis

The first problem can be answered by several methods depending on the investor's preferences and experience in socio-economic turmoil, dependence on investment capital, and fluctuations in investment income which are considered as risks, which are measured by the standard deviation of investment profit receipts. These factors can determine the risk coefficient on the following scale:

- Investment risk taker (“risk lover”),
- Neutral risk takers, and
- Risk avoider.

In this study, the method used is the standard deviation of investment returns on a weighted average. The weighted average of investment risk or RTRI is what determines the investment behavior profile of Indonesian private pension funds.

Second Problem Formulation Analysis

The analysis to answer the second problem formulation will be completed by applying the Markowitz theory (Efficient Frontier) and Single Index Model (SIM). In general, the implementation steps are carried out as follows

Table 1.2.
Second Problem Formulation Analysis Technique

<i>Markowitz Theory (Efficient Frontier)</i>		<i>Single Index Model Theory</i>	
The first step is to calculate the returns from each existing investment instrument. <i>Return</i>(return level) of each investment component measured using the formula:	$R_i = \frac{HK_i}{KI_i} \times 100\%$ Information: R_i = Return from each investment component HK_i = Investment result of investment component i KI_i = Total investment component i	<i>First step Calculating Expected returnshare s (E(Ri)) and Expected market return (E(Rm)) with the formula:</i>	$E(R_i) = \frac{\sum_{t=1}^n R_{it}}{n}$ $E(R_m) = \frac{\sum_{t=1}^n R_{mt}}{n}$
The second step is to calculate the expected return of each investment instrument. Expected return (expected rate of return) from each	$E(R_p) = \sum_{i=1}^n X_i \cdot E(R_i)$ Information: E(R_p) = Expected level of return from the portfolio X_i = Proportion of funds invested in investment component i	<i>The second step is to calculate the Risk Free Rate (Rf), Variance, and Standard Deviation.</i>	$R_f = \frac{\sum_{q=1}^p SBI_q}{P}$ $\sigma = \sqrt{\sum_{i=1}^n \frac{(X_i - \bar{X})^2}{n - 1}}$

investment component in a portfolio is measured by the formula:	$E(R_i)$ = Expected rate of return from investment component i		
The third step is to calculate the individual risk of each investment instrument. Investment risk is a deviation that occurs due to the difference between the actual return and the expected return from each investment component using the formula:	$\sigma_i = \sqrt{\frac{\sum_{j=1}^N [R_{ij} - E(R_i)]^2}{N}}$ Information: $E(R_i)$ = Expected rate of return from investment component i R_{ij} = Rate of return on investment component i N = Number of observations in 12 months σ_i = Standard deviation of investment component i	The third step is to calculate the beta and alpha of the investment instrument and its variance.	$\beta_i = \frac{\sum_{i=1}^n E(R_i) \cdot E(R_m)}{\sigma_m^2}$ $\alpha_i = E(R_i) - \beta_i \cdot E(R_M)$ $\sigma_{ei^2} = \sigma_{i^2} - \beta_i^2 \cdot \sigma_m$
The fourth step is to analyze covariance and correlation. The calculation of covariance can be done using the formula, namely:	$Cov(R_A, R_B) = \sigma_{AB} = \frac{\sum_{i=1}^n [(R_{Ai} - E(R_A)) \cdot (R_{Bi} - E(R_B))]}{n-1}$ By knowing the covariance, the correlation coefficient (ρ) can be found using the equation: $Cov(R_A, R_B) = \sigma_{AB} = \rho \cdot \sigma_A \sigma_B$ $\rho_{AB} = \frac{Cov_{AB}}{Cov_A Cov_B}$	The fourth step is calculating Excess Return to Beta Ratio (ERB Ratio) and Excess Return Standard Deviation (ERSD)	$ERB_i = \frac{E(R_i) - R_f}{\beta_i}$ $ERS_i = \frac{E(R_i) - R_f}{S_i}$
The fifth step is to calculate the risk and return of the portfolio.	<u>Portfolio Risk</u> In determining portfolio risk, standard deviation is used as a reference, the calculation of standard deviation can use the	The fifth step is to calculate the cut off rate (C_i) and cut off point (C^*), and	1) Sort each investment instrument based on the largest to smallest ERB value. 2) Calculate the values of A_j, $\sum A_j$ and

	calculation of variance first, because Standard Deviation is the root of variance. The following is the variance calculation formula for 6 portfolio instruments: $\sigma^2_p = [w_1^2 \cdot \sigma_1^2 + w_2^2 \cdot \sigma_2^2 + w_3^2 \cdot \sigma_3^2 + \dots + w_6^2 \cdot \sigma_6^2] + [2 \cdot w_1 \cdot w_2 \cdot \sigma_{12} + 2 \cdot w_1 \cdot w_3 \cdot \sigma_{13} + \dots + 2 \cdot w_1 \cdot w_6 \cdot \sigma_{16} + 2 \cdot w_2 \cdot w_3 \cdot \sigma_{23} + \dots + 2 \cdot w_2 \cdot w_6 \cdot \sigma_{26} + \dots + 2 \cdot w_5 \cdot w_6 \cdot \sigma_{5,6}]$ Or it can be written: $\sigma^2_p = \sum_{i=1}^n \sum_{j=1}^n w_i \cdot w_j \cdot \sigma_{ij}$ <u>ReturnPortfolio</u> Portfolio returns can be calculated by processing return data from each investment instrument and then combining them into a portfolio.	calculate the proportion of funds (Wi).	Bj, $\sum B_j$ for each investment instrument I using the formula following: $A_j = \frac{[E(R_i) - R_{BR}] \cdot \beta_i}{\sigma_{ei}^2}$ $B_j = \frac{\beta_i^2}{\sigma_{ei}^2}$ $C_i = \frac{\sigma_m^2 \cdot \sum A_j}{1 + \sigma_m^2 \cdot \sum B_j}$ The sizeCut off point(C*) is the largest Ci value, where the ERB value is greater than or equal to the ERB at point C*. Meanwhile, the proportion of funds can be calculated using the following formula: $W_i = \frac{Z_i}{\sum Z_i}$ $Z_i = \frac{\beta_i}{\sigma_{ei}^2} (ERB_i - C^*)$
The sixth step is Determining the Optimal Portfolio	By using information from 6 investment instruments, namely Government Securities (SBN), Bonds and Sukuk, stocks, savings/deposits, mutual funds, and land and buildings, an analysis will then be carried out to form an optimal portfolio composition, with several methods as follows: <u>Markowitz Theory/Model (Efficient Frontier/Mean-Variance Portfolio)</u> a. Global Minimum Variance Portfolio(GMV Portfolio)	The sixth step is calculating the alpha and beta of the portfolio and calculating the systematic risk and unique risk of the portfolio to produce the total return of the portfolio. And finally calculating the expected return of the portfolio (E(Rp)).	Alphaportfolio: $\alpha_p = \sum_{i=1}^n w_i \cdot \alpha_i$ Betaportfolio: $\beta_p = \sum_{i=1}^n w_i \cdot \beta_i$ Portfolio systematic risk: $\beta_p^2 \cdot \sigma_m^2$ Unique portfolio risks: $\sigma^2_{ep} = \sum_{i=1}^n w_i^2 \cdot \sigma_{ei}^2$ Total portfolio risk is the sum of the

	GMV portfolio has the lowest risk level of all efficient portfolio compositions generated from the Efficient Frontier. Here are the steps to find the GMV portfolio. Terms/limitations $W_1 + W_2 + W_3 + W_4 + W_5 + W_6 = 1$ W_i is greater than or equal to zero ($W_i \geq 0$). The above equation can be solved using Lagrange and simultaneous equations (simplex) or with the help of the MS Excel Solver computer program. <i>b. Optimal Portfolio at a Certain Level of Expected Return (Efficient Frontier)</i> The efficient frontier curve is a curve formed from a collection of efficient portfolios that are above the GMV portfolio with different asset compositions and produce the highest level of profit with a certain level of risk or vice versa. In calculating and describing the efficient frontier, the method is almost the same as finding the GMV portfolio with the addition of a constraint function. The equation used for the Efficient Frontier is as follows: Terms/limitations • $W_1 + W_2 + W_3 + W_4 = 1$ • The W_i value is greater than or equal to zero ($W_i \geq 0$) • $E(RP) = \sum_{i=1}^n w_i E(R_i)$	<i>systematic risk and the unique risk of the portfolio.</i> <i>Expected return portfolio (E(Rp)):</i> $E(R_p) = \alpha_p \cdot \beta_p E(R_m)$
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	The above equation can be solved using Lagrange and simultaneous equations (simplex) or with the help of the MS Excel Solver computer program by adding boundary conditions $E(R_p)$. c. <i>Optimal Portfolio with Risk-Free Asset (Tangency portfolio)</i> This portfolio position is obtained by finding the maximum slope angle on the efficient frontier curve using the equation: $\tan \alpha = \frac{E(R_p) - R_f}{\sigma_p}$ Furthermore, to find the tangency portfolio, this can be done by maximizing the value of $\tan \alpha$ on the efficient frontier curve.		
<u>Measuring Portfolio Performance (Sharpe, Jensen, Treynor)</u> In measuring portfolio performance, testing can be done by calculating 3 commonly used ratios, namely Sharpe, Jansen, and Treynor. It should be underlined that of the three types of ratios above, this study specifically uses the Treynor ratio in the context of a single index model or SIM.			

Source: Processed by the author from various sources

Specifically to answer H0 of the second problem formulation, the test of the difference in average investment returns using the Markowitz and SIM approaches can be carried out using the Mann-Whitney Test analysis with the following explanation:

According to Anggorowati, MT, M. Ari (2013), to test whether 2 independent samples come from the same population, the test that can be used is the U Mann-Whitney. This test is also used to determine the comparison of the medians of 2 independent groups in the dependent variable data scale is ordinal or interval / ratio but is not normally distributed. Based on the explanation above, the Mann Whitney Test or Mann Whitney U Test requires data on an ordinal, interval or ratio scale. In Ginanjar Syamsuar (2020), the Mann-Whitney U test is also called Mann–Whitney–Wilcoxon (MWW) is an alternative test to the t-test. This test is a non-parametric test used to compare two population medians that come from the same population, also used to test whether two population medians are the same or not. The Mann-Whitney test is used to determine whether or not there is a difference between two independent samples. The Mann-Whitney test is a non-parametric test that can be an alternative to the t-test, which is a parametric test. The α value used is usually 5% (0.05). The hypothesis for this U test is:

$$H_0: \mu_1 = \mu_2$$

$$H_a: \mu_1 \neq \mu_2$$

Meanwhile, the basis for decision making in the non-parametric Mann-Whitney test is as follows:

- a. *If the Asymp.Sig. (2-tailed) value > 0.05, then Ho is not rejected.*
- b. *If the Asymp.Sig. (2-tailed) value < 0.05, then Ho is rejected.*

Analysis of the Third Problem Formulation

The analysis to answer the third problem formulation will be completed by applying non-parametric statistical techniques, especially the Kruskal-Wallis test method, or Analysis of Variance (ANOVA) in parametric statistics. This hypothesis testing technique compares the average investment returns on the three types of pension funds. The Kruskal-Wallis test procedure is carried out with the following steps:
 The first step is to rank the average investment returns of the three types of pension funds (n1 = DPPK-PPMP, n2 = DPPK-PPIP, and n3 = Financial Institution Pension Funds) as a whole, after determining the number of samples for each observation of the three types of pension funds. The sample for each type of observation is determined to be six (6) investment returns. The second step is to add up the ranking numbers of each type of pension fund with statistical symbols ($\sum R1$ = DPPK-PPMP, $\sum R2$ = DPPK-PPIP, and $\sum R3$ = Financial institution pension fund).

The third step is to enter the results of $\sum R1$, $\sum R2$, and $\sum R3$ in the following formula:

$$H = \frac{12}{n(n+1)} \times \sum (R1^2/n1 + R2^2/n2 + R3^2/n3) - 3(n+1), \text{ with explanation}$$

H = Kruskal-Wallis test or F value in parametric statistics
n = Number of observations
Constant numbers = 12, 3, and 1

The fourth step is testing H0 itself. If the calculated H value is greater than the H value in the table, H0 must be rejected, which means that the difference in the return levels of the types of pension fund investments is quite large. Conversely, if H0 is accepted.

Hypothesis Development

Hypothesis for the second problem formulation

Null hypothesis (H0): “There is no difference in the amount of private pension fund stock investment income using MPT and SIM theories.”

Hypothesis for the third problem formulation

Null hypothesis (H0): “There is no difference in the level of investment income of the types of Employer Pension Funds-Defined Benefit Pension Programs (DPPK-PPMP), Employer Pension Funds-Defined Contribution Pension Programs (DPPK-PPIP), and Financial Institution Pension Funds (DPLK)

3. Results

Private pension fund investments in Indonesia over a five (5) year period (2019-2023) are analyzed and discussed from the perspective of a description of the behavior of private pension fund companies in making investment decisions, optimizing investment profits and risks by applying the "modern portfolio theory" or MPT theory, and testing differences in the achievement of investment profits by Indonesian private pension funds.
 Investment Decision Behavior of Indonesian Pension Fund Companies

To be able to see the behavior of investment decisions of private pension fund companies in Indonesia, it can be done by calculating the weighted average investment risk (RTRI). The way to calculate RTRI is by multiplying the investment risk (standard deviation) by the weight or proportion of the amount of managed funds from each pension fund program. See Table 4.1. below.

Table 1.3.
 Total Investment Funds Managed by Private Pension Funds in Indonesia (in billion rupiah)

Investment Instrument Share	PPMP		PPIP		DPLK	
	Managed Funds (billion rupiah)	Proport ion (%)	Managed Funds (billion rupiah)	Proporti on (%)	Managed Funds (billion rupiah)	Proportio n (%)
	18,516	11.0%	6,936	15.9%	2,673	2.0%
Mutual Funds	6,125	3.6%	1,111	2.5%	4,926	3.7%
Bonds & Sukuk	41,958	25.0%	10,261	23.5%	15,322	11.6%
SBN	70,236	41.9%	18,917	43.3%	37,926	28.7%
Savings & Deposits	16,292	9.7%	5,317	12.2%	71,335	54.0%
Land & Building	14,687	8.8%	1,110	2.5%	22	0.0%
Amount	167,814	100.0%	43,652	100.0%	132,205	100.0%

Source: OJK Pension Fund Monthly Statistics

After knowing the proportion of the amount of managed funds invested in each investment instrument, the weighted average investment risk (RTRI) can be calculated by multiplying the proportion in the table above by the risk (standard deviation) of each investment instrument for each pension fund program. See Table 4.2. below.

Table 1.4.
Weighted Average Investment Risk (RTRI) of Private Pension Funds in Indonesia

Investment Instrument Share	PPMP		PPIP		DPLK	
	S (risk/standard deviation)	RTRI	S (risk/standard deviation)	RTRI	S (risk/standard deviation)	RTRI
	5.3%	0.6%	7.3%	1.2%	22.1%	0.4%
Mutual Funds	6.2%	0.2%	10.3%	0.3%	32.5%	1.2%
Bonds & Sukuk	4.5%	1.1%	5.3%	1.3%	10.4%	1.2%
SBN	2.8%	1.2%	10.4%	4.5%	4.2%	1.2%
Savings & Deposits	11.1%	1.1%	7.1%	0.9%	4.9%	2.6%
Land & Building	2.6%	0.2%	6.3%	0.2%	3.7%	0.0%
Amount		4.4%		8.2%		6.7%

Source: Processed by the author from various sources

Based on table 4.2. above, the investment decisions of private company pension funds actually show more “risk avoider” behavior than “risk lover” due to RTRI or the weighted average of investment risk which is more focused on fixed income securities investments; such as bonds and sukuk, SBN, and savings, each of which shows the largest weight for all programs. The details for each program are as follows:

- The PPMP program shows a total weight of 3.4%, consisting of 1.1% for bonds and sukuk, 1.2% for SBN, and 1.1% for savings and deposits. This amount is around 77.27% of the total RTRI weight of 4.4%.
- The PPIP program shows a total weight of 6.7%, consisting of 1.3% for bonds and sukuk, 4.5% for SBN, and 0.9% for savings and deposits. This amount is around 81.70% of the total RTRI weight of 8.2%.
- The DPLK program shows a total weight of 5.0%, consisting of 1.2% for bonds and sukuk, 1.2% for SBN, and 2.6% for savings and deposits. This amount is around 74.62% of the total RTRI weight of 6.7%.

Solihin, I. (2024) said that the Republic of Indonesia's APBN deficit is more strategic if it is obtained from SBN financing sources. For example, the APBN deficit can be reduced to IDR 347.6 trillion in 2023 or reduced by 1.65% of the country's gross domestic product or GDP through SBN financing.

Optimizing Profit and Risk of Pension Fund Investment

The analysis of the optimization of investment profits of the PPMP, PPIP, and DPLK pension fund programs is carried out in two (2) steps. First, testing H0: ROI (actual investment income or "return on investment") = ROI (calculated using the Treynor single index model method)

Table 1.5.

Investment Portfolio Analysis: Efficient Frontier vs SIM

Year	Risk Free Rate(Rf)	Beta (β)	ROI	ROISI M	Weight	Varian ce
PPMP						
2019	6.909	1.254	-4,200	-8,862		
2020	4.237		9.100	3,879		
2021	3.465		-0.600	-3.243		
2022	6,071		-0.600	-5.322		
2023	6.909		-3,200	-8,064		
Weight :						
Coef -1					50-50	0.0
Coef +1					100-0	26.2
PPIP						
2019	6.909	1,241	7,580	0.541		
2020	4.237		14.110	7,957		
2021	3.465		-1,630	-4.106		
2022	6,071		-6.930	-10,478		
2023	6.909		1.140	-4,650		
Weight :						
Coef -1					50-50	0.4
Coef +1					100-0	49
DPLK						
2019	6.909	1,249	17,750	8,678		
2020	4.237		40,080	28,691		
2021	3.465		-25,810	-23,433		
2022	6,071		-5,070	-8,918		
2023	6.909		2,890	-3.217		
Weight :						
Coef -1					40-60	3.5
Coef +1					100-0	404.5

Source: OJK Pension Fund Statistics, processed by the author

The first step also includes details of a simple ROI calculation using the Treynor ratio method, which is considered more suitable as a single index model method because it measures market risk better to be designed as a more risk-averse investment portfolio tool (CFI Team, 2024). Second, by applying

Markowitz's modern portfolio theory, an evaluation of the optimal composition of pension fund investment income from the three programs is expected to further minimize risk.

- Pension fund investment net income or ROI oriented single index Treynor ratio model, which is calculated as follows:
 $ROI = (ROI - ROISIM) / (Cov / Var)$, where
 - ROI is actual net income,
 - ROISIM is net income calculated using the Treynor ratio,
 - Cov is the covariance of actual income, and
 - Var is the variance of actual income.PPMP2023: $ROI = (-3,200 - 6,909) / (0.351 / 0.280)$ or -8,064
PPIP2023: $ROI = (1.140 - 6,909) / (0.670 / 0.540)$ or -4.650
DPLKA 2023: $ROI = (2,890 - 6,909) / (6,109 / 4,890)$ or -3,217
- According to the standard calculation presented in Appendix E, at a coefficient of -1 the optimal stock investment portfolio diversification weight is at 50% of stocks with actual returns and 50% of stocks with returns that take into account SIM for PPMP and PPIP; while the optimization for DPLK is at 40% of stocks with actual returns and 60% of stocks with returns that take into account SIM. See Table 4.3 above.

To answer H0: “There is no difference in the level of investment income of the types of Employer Pension Funds-Defined Benefit Pension Programs (DPPK-PPMP), Employer Pension Funds-Defined Contribution Pension Programs (DPPK-PPIP), and Financial Institution Pension Funds.” – the application of the non-parametric Mann-Whitney method shows that stock and SBN investments, as Rf factors or investments that are not risky or less risky, do not show any difference at the 0.05 confidence level. See the inter-correlation review in Chapter 4. See Table 4.4. below.

Table 1.6.

ROI-Generating Investment Testing or ROISIM

PROGRA M	U- Value	z-value	p-value	INTERPRETATIO N
PPMP	5,000	1,462	0.144	H0 is accepted
PPIP	8,000	0.836	0.401	H0 is accepted
DPLK	11,000	0.209	0.834	H0 is accepted

Source: OJK Pension Fund Statistics, processed by the author

Private Pension Fund Investment Profit Difference Test

Using the non-parametric method, this research question seeks to answer the null hypothesis (H0): "There is no difference in the level of investment income of the Employer Pension Fund-Defined Benefit Pension Program (DPPK-PPMP), Employer Pension Fund-Defined Contribution Pension Program (DPPK-PPIP), and Financial Institution Pension Fund" in terms of:

- Aggregate, as well as
- According to each investment instrument (stocks, mutual funds, bonds and sukuk, SBN, deposits, and land and buildings).

The combined income and income of each investment of the three types of pension fund programs were tested using the non-parametric Kruskal-Wallis approach, which showed differences in the investment profit patterns of funds obtained from the PPMP, PPIP and DPLK programs, both in aggregate and according to each investment instrument.

Aggregate Investment Income Level

The aggregate investment income level of the PPMP, PPIP, and DPLK pension programs, apparently shows differences from the results of the Kruskal-Wallis non-parametric test below.

Table 1.7.

Kruskal-Wallis Non-parametric Test Calculation in Aggregate

Types of Pension Fund Programs	2019	2020	2021	2022	2023	Averag e

PPMP	2.71	4.67	-0.68	-2.10	1.48	6.08
PPIP	3.18	5.85	1.77	-2.30	3.95	12.45
DPLK	11.6	24.25	-1.26	2.78	5.05	42.42

Source: OJK Pension Fund Statistics, processed by the author

By applying the Kruskal-Wallis formula, the calculation of the non-parametric Kruskal-Wallis test in aggregate produces a value of H = -28.06 with details of n = 15 for the three programs.

$$\begin{aligned}
 H &= 12/15 (15 + 1) \times (6.082/5 + 12.452/5 + 42.422/5) - 3(15 + 1) \\
 H &= 0.05 \times (7.39 + 31.50 + 359.89) - 48 \\
 H &= -28.06
 \end{aligned}$$

The value of H = -28.06, at a confidence level of 0.05 with a degree of freedom (df) or statistical freedom degrees of the number of pension fund programs observed; namely, three (3) programs, PPMP, PPIP, and PPLK, or df = 2 (3 programs - 1), which in the table indicates a value of 5.99, shows that H0 "there is no difference in pension program investment income" must be rejected. So, there is indeed a difference between the pension programs.

Investment Income Level According to Each Instrument

The differences mentioned above can be seen from all H values, which are the same as the F value in parametric statistics, all of which are greater than the H critical value at a confidence level of 0.05 with a degree of freedom (df) or statistical freedom degrees of the number of pension fund programs observed; namely, three (3) programs, PPMP, PPIP, and PPLK, or df = 2 (3 programs - 1), which in the table indicates a value of 5.99. For example, pension fund program stock investment shows an H value of -37.06, which is greater than the H critical value (df = 2, p = 0.05) of 5.99, thus requiring the rejection of H0 with the declaration "there is a difference in the level of investment income of the three private pension fund programs in Indonesia."

Table 1.8.
Calculation of Non-parametric Kruskal-Wallis Test of Investment Instruments

Types of Pension Fund Programs	Share	Mutual Funds	Bonds & Sukuk	SBN	Savings	Land & Building
PPMP	0.25	2877.25	112.28	3800.72	67.24	322.20
PPIP	203.63	4823.30	817.39	8190.25	534.07	151.29
PPLK	890.43	1904.45	702.25	7849.96	1586.43	91.01
Calculation						
12/n(n+1)	0.05	0.05	0.05	0.05	0.05	0.05
ΣR ² /n	218.86	1921.00	326.39	3968.18	437.55	112.90
3(n+1)	48.00	48.00	48.00	48.00	48.00	48.00
H Value	-37.06	48.05	-31.68	150.41	-26.12	-42.36
H (df, p=5%)	5.99	5.99	5.99	5.99	5.99	5.99

Source: OJK Pension Fund Statistics, processed by the author

Inter-correlation Between Investment Instruments of PPMP, PPIP, and DPLK Programs

After the difference in investment income levels is tested, inter-correlation between investment instruments is carried out to see the relationship between one investment instrument and another, which is very important for pension fund program portfolio management as stated by Arbeleche, S. et. al. (2021). Some findings from the pension program portfolio management behavior being studied are presented below. See Table 4.7. below.

Table 1.9.
Correlation Matrix (r) of Income Levels of PPMP, PPIP, and DPLK Investment Instruments

PPMP	Share	Mutual Funds	Bonds & Sukuk	SBN	Savings & Deposits	Land & Building
Share	0.351%					
Mutual Funds	0.257%	0.474%				

Bonds & Sukuk	0.122%	-0.053%	0.254%			
SBN	-0.004%	0.081%	-0.132%	0.096%		
Savings & Deposits	-0.005%	-0.089%	0.201%	-0.271%	1,530%	
Land & Building	-0.051%	-0.172%	0.079%	-0.048%	-0.012%	0.082%

PPIP	Share	Mutual Funds	Bonds & Sukuk	SBN	Savings & Deposits	Land & Building
Share	0.670%					
Mutual Funds	0.683%	1.335%				
Bonds & Sukuk	0.384%	0.583%	0.353%			
SBN	-0.756%	-1.154%	-0.677%	1.350%		
Savings & Deposits	0.501%	0.551%	0.216%	-0.533%	0.626%	
Land & Building	-0.150%	-0.042%	0.047%	0.054%	-0.437%	0.497%

DPLK	Share	Mutual Funds	Bonds & Sukuk	SBN	Savings & Deposits	Land & Building
Share	1,000					
Mutual Funds	0.767	1,000				
Bonds & Sukuk	0.468	0.036	1,000			
SBN	-0.719	-0.807	-0.060	1,000		
Savings & Deposits	0.641	0.264	0.117	-0.112	1,000	
Land & Building	-0.014	-0.101	-0.394	0.045	0.393	1,000

Source: OJK Pension Fund Statistics, processed by the author

- First, the inter-correlation behavior of the PPMP program investment instruments does not show any significant relationship at all.
- Second, the PPIP program turned out to show the most connections between investment instruments, which illustrates the following behavior:
 - In the mutual fund investment portfolio; diversification of SBN, bonds and savings, shows a very significant coefficient with each coefficient (r) of -1.154, +0.583, and +0.551. In addition to SBN as a component of mutual fund investment, PPIP also shows that private pension fund companies in Indonesia choose to invest directly in SBN, considering the prudential principle of the PPIP program.
 - With r = -0.756, it can be seen that the choice of stock investment is made by considering the level of SBN income because the coefficient is inverse, the same as the choice of bonds and SBN (r = -0.677).
- Third, similar to other programs, DPLK also shows an inverse coefficient between stock investment or mutual funds with r = -0.719 and -0.807 respectively

4. Discussion

Related to the behavior of pension fund managers in making investment decisions in this study, it can be seen that the three types of pension fund programs, namely Employer Pension Funds-Defined Benefit Pension Programs (DPPK-PPMP), Employer Pension Funds-Defined Contribution Pension Programs (DPPK-PPIP), and Financial Institution Pension Funds (DPLK) still tend towards "risk-avoiders" where this can be seen from the weighted average investment risk which is more focused on investments in fixed income investment instruments, such as bonds and sukuk, SBN, and savings, each of which shows the largest weight for all programs. The implication of the findings that answer the first problem formulation is by knowing the characteristics of investment behavior of pension fund managers in Indonesia which are more towards risk-avoiders, which means this can be an answer for people who question the return or growth of funds stored in pension funds. The implication of this risk-avoider characteristic is that the return from the investment made tends to be smaller because they do not dare to take risks in investing. However, on the other hand, this characteristic is chosen for the reason of being able to secure public funds managed by pension funds.

By applying the single index model (SIM) theory and the Treynor ratio method as the ratio considered most appropriate to be used together with the SIM theory, the results of the optimal portfolio composition of the three types of pension fund programs in Indonesia are as follows:

- The optimal portfolio composition of the Employer Pension Fund-Defined Benefit Pension Plan (DPPK-PPMP) is 50% stocks with actual returns and 50% stocks with returns that take into account SIM.
- The optimal portfolio composition of the Employer Pension Fund-Defined Contribution Pension Program (DPPK-PPIP) is 50% stocks with actual returns and 50% stocks with returns that take into account SIM.
- The optimal portfolio composition of the Financial Institution Pension Fund (DPLK) is 40% shares with actual returns and 60% shares with returns that take into account SIM.

The implication of the findings that answer the second problem formulation is that the return on investment (ROI) of investments made by each type of pension fund program in Indonesia is still not optimal and can be optimized. From these findings, it is expected that pension fund management institutions can review their investment portfolios in order to produce better ROI. In the third problem formulation, it is desired to know whether there is a difference in the returns generated by each type of Pension Fund program. This will be divided into two analyses, namely aggregate or combining all investment instruments or and individually for each investment instrument. The results of the analysis for the third problem formulation are as follows:

- In aggregate, there are differences in returns from each type of Pension Fund program.
- Individually for each investment instrument there are also differences in returns on each type of Pension Fund program. In addition, an intercorrelation analysis was also carried out to determine whether there is a significant correlation or interrelationship between investment instruments or not. The results of the analysis obtained the following results:
- The Employer Pension Fund-Defined Benefit Pension Program (DPPK-PPMP) has an inter-correlation behavior of investment instruments that does not show any significant relationship at all.
- Employer Pension Fund-Defined Contribution Pension Program (DPPK-PPIP) shows the most links between investment instruments.
- The Financial Institution Pension Fund (DPLK) also shows the relationship between investment instruments, although not as much as in the PPIP program.
- The implication of the findings that answer the second problem formulation is that each type of pension fund program has differences in investment income. This is feared to be unfair to the community because those who participate in one pension fund program will have a different ROI compared to other people who participate in other pension fund programs

5. Conclusion

The behavior of pension fund managers in Indonesia in making investment decisions still tends towards "risk-avoider", this applies to the three types of existing pension fund programs. The result of this behavior is the low return on investment (ROI) obtained from pension fund investments. Optimization of the ROI of pension fund investments should still be possible, because if tested with the Single Index Model (SIM) theory, the ROI of pension fund investments is still not optimal. If the ROI is more optimal, of course the public will be more interested in participating in pension funds. In addition, based on the analysis carried out, there are still differences in investment income between the three types of pension fund programs. This will certainly cause inequality due to differences in returns that will be obtained by participants for each type of pension fund program. This difference is likely due to differences in the profile or characteristics of pension fund participants which ultimately affect the decision to choose investment instruments for each type of pension fund program.

Limitations and suggestions

Theoretical Suggestions

For subsequent researchers, this research can still be developed, especially in providing suggestions for optimal portfolio composition in terms of return (yield) along with the amount of investment weight in each available investment instrument. The formation of an optimal portfolio can also be analyzed with other theories so that input for pension fund institutions can also be more complete and comprehensive.

Practical Advice

The practical suggestions that can be given to several related parties so that they can be carried out in accordance with the results of this study are as follows:

1. For pension fund management institutions, with the results that answer the first problem formulation, the behavior of pension fund managers in Indonesia in making investment decisions still tends to avoid risk (risk-avoider). This causes investment returns in pension funds to tend to be smaller than investments elsewhere. This is actually quite good for the principle of prudence, but on the other

hand it also has a negative effect where public funds become less developed and are feared to be eroded by inflation that continues to occur every year. In addition, with small returns (yields), it is feared that it will be an obstacle in attracting public interest to participate more in pension fund programs. One suggestion for pension fund management institutions to be more daring in taking risks in investing is to group the use of invested funds based on the age of pension fund participants. It is possible that if the age of the participants is still young, the investment made can be in more aggressive instruments and vice versa.

2. For the government, it is better to be able to further improve supervision and monitoring of the performance of each pension fund institution. In addition, the government should also be able to create regulations that allow pension fund institutions to be more flexible in investing their managed funds. This is expected to increase the return (yield) of pension fund investments, while on the other hand maintaining security and continuing to apply the principle of prudence in managing public pension funds.

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