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Case Study

Analysis and Optimization of Investment Portfolio Performance (Case Study of PLN Pension Fund)

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ABSTRACT

This study aimed to analyses the performance of each asset in the investment portfolio using the risk-adjusted performance and also to analyses the composition of the investment portfolio that can provide optimal results using single-index model and tangency portfolio on the PLN Pension Fund. Based on historical data, PLN's Pension Fund investment portfolio currently has not achieved the expected rate of return. This study uses secondary data from the PLN Pension Fund investment division consisting of investment allocation and returns data for each asset. The results based on risk-adjusted performance using the Sharpe ratio, Treynor ratio, and Jensen alpha are mutual funds that have suboptimal performance. Based on the results of optimal portfolio composition, the single-index model and tangency portfolio can provide an optimal rate of return with a lower level of risk compared to the historical portfolio of the PLN Pension Fund. However, the portfolio composition produced by the single-index model is not following PLN's Pension Fund investment policy, the allocation of government bonds exceeds the maximum quantitative limit. The portfolio assessed using the Sharpe ratio, tangency portfolio has the highest Sharpe ratio. So the portfolio formed based on tangency portfolio is the best portfolio combination.

Keywords: PLN Pension fund, return, risk, single-index model, tangency portfolio.

INTRODUCTION

The PLN Pension Fund is a legal entity established by a company that manages and organizes a Definite Benefit Pension Program (PPMP). The purpose and objective of establishing the PLN Pension Fund are to manage and develop funds to hold PPMP to guarantee and maintain the continuity of income in old age for participants and entitled parties. Unlike the Pension Fund that runs the Defined Contribution Pension Program (PPIP), the risk of investing in pension funds with the PPIP program is emphasized on participants of the pension program. The PPMP program is considered quite burdensome, in addition to the risk of cash flow problems, pension fund companies are also at risk of experiencing a deficit, where the contributions paid are not proportional or lower than the benefits in the form of benefits provided each month to employees who have retired.

The wealth of the PLN Pension Fund is collected from a variety of sources including participant contributions, employer contributions, investment returns and the transfer of funds from other pension funds. In managing funds, pension funds are required to develop optimally through investments made by investment directives by the founder and the conditions set by the government. In the world of investment, known as the term high-risk high-return,

low-risk low-return, where the higher the return, the higher the risk and vice versa.

Additional assets of the PLN Pension Fund can occur with an increase or decrease in the value of investments and contributions consisting of participant contributions and employer contributions and additional contributions. As for the reduction of PLN Pension Fund assets, there is an investment cost and income tax. Based on Table 1, the amount of assets over the past six years has fluctuated, it cannot be separated from the return and claims for pension benefits. PLN's Pension Fund Return has continued to increase for six years, but this has not been able to cover the reduction in assets and claims for pension benefits that continue to increase every year which causes a deficit in 2013 and 2015. So that special attention is needed from the founders and management regarding governance in the pension fund development.

Table 1: Changes of PLN PensionFund Assets In millions of Rupiah

Years	Net Assets at the Beginning	Return	Addition of Net Assets (total)	Reduction of Net Assets	Claim	Net Assets at the End
2013	6.660.201	610.030	465.144	78.129	462.700	6.584.515
2014	6.584.515	630.421	1.245.587	79.536	513.368	7.237.199
2015	7.237.199	635.892	518.553	76.762	553.334	7.125.656
2016	7.125.656	627.407	1.311.245	72.840	640.787	7.723.274
2017	7.723.274	670.413	1.291.399	79.604	760.262	8.174.807
2018	8.174.807	698.976	1.911.600	112.830	806.438	9.167.139

Risks in investment activities cannot be eliminated but can be minimized. Therefore, it is needed a strategy and implementation of portfolio management by the investment characteristics of pension funds in preparing an optimal portfolio to be able to minimize risk. Besides, for investments made to provide optimal results according to investment targets, pension funds must pay attention to the determination of strategic assets and diversify their portfolios. This is in line with Tandelilin (2010) [1] which states that investors are advised to diversify their portfolios so that the risk from one asset to another is compensated for each other and does not significantly influence investor profits.

Diversification is a way that investors do by choosing a combination of several assets in such a way that investment risk can be minimized without reducing expected return. Then, it was proven in Markowitz's research (1952) [2] where investment risk can be minimized by combining several assets in a portfolio. According to Jones (2009), [3] a portfolio is security held by an investor as a unit.

Informing a portfolio, companies need to conduct an analysis of the risk and return of each asset to establish portfolio diversification policies. Also, performance analysis is needed to find out the resulting performance reaches predetermined targets, whether that includes combined portfolio returns or each class of investment assets or fund managers used (Ardianto, 2004). [4]

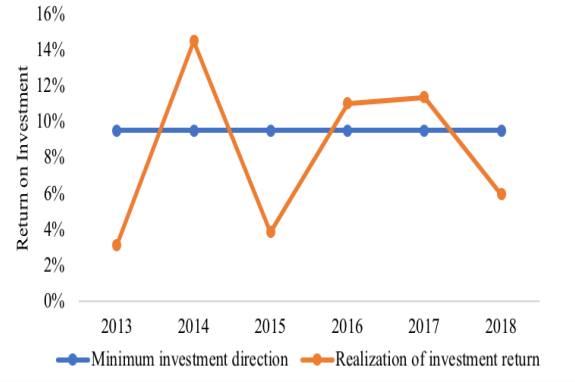

Figure1. Comparisonofreturnswith minimum investment directives of the PLN PensionFund

Based on Figure 1, it appears that the PLN Pension Fund return is quite volatile. In 2013, 2015 and 2018, the realization of investment return was 3.12%, 3.82% and 5.93%, which was lower than the minimum investment directives of the PLN Pension Fund. The minimum investment direction is the investment return target set in the investment direction based on the founder's

decision in 1 year of at least 9.50% of the total investment. Portfolio analysis is very important for institutional investors and individual investors so that the formed portfolio can be optimal.

Ezugwu (2014) [5] states that there is a direct relationship between the size of assets in a portfolio and portfolio returns. Furthermore, Amalia (2012) [6] by using the mean-variance model in pension funds x, argues that the average portfolio performance of pension funds x is still lower compared to portfolio tangency. This is in line with research conducted by Vincent et al. (2019), [7] where tangency portfolio is chosen as the best portfolio maker. The objectives of this study are:

Analyzing the performance of each portfolio asset formed in the PLN Pension Fund.

Analyzing the composition and characteristics of an efficient investment portfolio (asset allocation) based on historical data that can be considered by the PLN Pension Fund.

RESEARCH METHODS

Types and Data Sources

This research uses a case study method approach. Analysis of the data used is a quantitative method that is limited to PLN's Pension Fund investment portfolio data in the period January 2015 to December 2018 from internal companies. The data is the allocation and return data of assets consisting of government bonds, deposits, bonds, stocks, and mutual funds. Then the performance analysis using the risk-adjusted performance method and the optimization of the investment portfolio using a single-index model and tangency portfolio. To complete the analysis needs, additional data is needed such as the BI Reverse Repo Rate as a risk-free asset, and the benchmark for each asset consists of the Composite Stock Price Index (IHSG), the InfovestaGovernmental Bond Index (IGBI), the Infovesta Corporate Bond Index (ICBI), and the Infovesta Balanced Fund Index (IBFI).

Return

Before an investment portfolio analysis is performed, a return calculation is required for each asset. The return types used for each asset are as follows.

Table2: Typesofreturnsforeach PLN PensionFundasset

Types of Asset	Returns
Government Securities	Coupon dan Capital Gain
Time Deposits	Interest
Bonds	Coupon dan Capital Gain
Stocks	Dividend dan Capital Gain
Mutual Funds	NAB dan Capital Gain

Risk

The calculation of risk for each asset is carried out using the standard deviation indicator. The formula used to calculate the standard deviation according to Bodie et al. (2010). [8]

$$\sigma^2{}_i = \frac{1}{n}\sum_{i=1}^{n}[r_{it} - \bar{r}_i]^2$$

Historical beta (systematic risk) is calculated by comparing the covariance of assets and markets with variance of the market. Elton and Gruber (1995) [9] state that historical beta can be searched by equation.

$$\beta_i = \frac{\sigma_{mi}}{\sigma^2{}_m} = \frac{\sum_{t=1}^{n}[(r_{it} - \bar{r}_i)(r_{mit} - \bar{r}_{mi})]}{\sum_{t=1}^{n}[(r_{mit} - \bar{r}_{mi})^2}$$

Covariance and Correlation

Covariance in the context of portfolio management shows the extent to which returns from two assets tend to move together. According to Bodie et al. (2010), [8] covariance is expressed by equations.

$$\mathrm{Cov}(r_i, r_j) = \mathrm{E}\{[w_i r_i - w_i \mathrm{E}(r_i)][w_j r_j - w_j \mathrm{E}(r_j)]$$

To simplify calculations, the covar function (argument1, argument2) is used where argument1 contains the 1st asset return data and argument2 contains the 2nd asset return data during the research period in Microsoft Excel software. Then for other columns adjusted to the position of the instrument being calculated. While the correlation coefficient can be stated in the following equation (Bodie et al. 2010). [8]

$$\mathrm{Corr}(r_i, r_j) = \frac{\mathrm{Cov}(r_i, r_j)}{\sigma_i \sigma_j}$$

Return and Risk Portfolio

Portfolio returns can be calculated by accumulating the return of each asset multiplied by the weight of each asset. While portfolio variance are obtained by multiplying the covariance between assets by the weight of each asset in the portfolio. According to Bodie et al. (2010), [8] variance can be expressed by equations.

$$\sigma_p{}^2 = \sum_{i=1}^{n} w^2{}_i \sigma^2{}_i + \sum_{i=1}^{n} \sum_{i=1}^{n} w_i w_j \ Cov(r_i, r_j)$$

Performance Analyses of Each Asset

The performance of each asset is measured using risk-adjusted performance with three measurement methods. The risk-free asset indicator used in this study is using the BI Reverse Repo Rate.

1. Sharpe ratio

Sharpe ratio uses total measured risk (systematic and unsystematic risk) as indicated by the standard deviation of assets (Arugaslan et al. 2008). [10] Sharpe measurements were formulated according to Bodie et al. (2010). [8]

$$S_i = \frac{\bar{r}_i - \bar{r}_f}{\sigma_i}$$

2. Treynor ratio

Treynor measurement is based on risk premium($\bar{r}_i - \bar{r}_f$)as well as the Sharpe ratio. This measurement was formulated according to Bodie et al. (2010). [8]

$$T_i = \frac{\bar{r}_i - \bar{r}_f}{\beta_i}$$

3. Jensen ratio

Jensen's measurements were formulated according to Bodie et al. (2010). [8]

$$\alpha_{pi} = \bar{r}_i - [\bar{r}_f + \beta_i(\bar{r}_{mi} - \bar{r}_f)$$

Selecting the Optimal Investment Portfolios

1. Single-Index Model

According to Elton and Gruber (1995), [10] the rules in calculating which assets will be included in the optimal portfolio are as follows.

a. Look for the ERB ratio for each asset included in the consideration and rank it from the largest to the smallest.ERB (excess return to beta) can be obtained by reducing the rate of return of each instrument with the risk-free asset. After the excess return value is obtained, then the excess return is divided by beta so that the ERB is obtained.

b. The optimal portfolio contains assets whose ERB value is greater than the cutt-off C^*. Calculation of cutt-off rate (C_i)aims to determine the unique cutt-off C^*. Elton and Gruber (1995) [10] provide equations regarding assets that enter the portfolio, ie assets that have an ERB above the cut-off rate.

$$C_i = \frac{\sigma^2{}_m \sum_{i=1}^{n} \frac{(\bar{r}_i - r_f)\beta_i}{\sigma_e{}^2{}_i}}{1 + \sigma_m{}^2 \sum_{i=1}^{n} (\frac{\beta^2{}_i}{\sigma_e{}^2{}_i})}$$

$$C^* = \max C_i$$

Optimal portfolio selection is meant by comparing the value of ERB and C_i then the formation of the portfolio can be determined as follows.

ERB>C^*, the assets concerned are included in the portfolio.

ERB <C^*, the assets concerned are not included in the portfolio.

According to Fischer and Jordan (1999), [11] after it is known which assets are included in the optimal portfolio, then the percentage of investment in each asset must be taken into account.

$$w_i = \frac{Z_i}{\sum_{j=1}^{n} Z_j}$$

with,

$$Z_i = \frac{\beta_i}{\sigma^2{}_i}\left[\frac{r - r_f}{\beta_i} - C^*\right]$$

2. Tangency Portfolio

Tangency portfolio can be sought by maximizing the value of tan α by calculation (Bodie et al, 2010). [8]

$$\tan \alpha = \frac{E(r_p) - r_f}{\sigma_p}$$

This optimal portfolio can be completed using the MS Excel Solver program or can be completed manually with simultaneous equations.

$$Z_i\sigma^2{}_1 + Z_2\sigma_{12} + \cdots + Z_i\sigma_{1i}) = [E(R_1) - R_f]$$
$$Z_1\sigma_{21} + Z_2\sigma^2{}_2 + \cdots + Z_i\sigma_{2i}) = [E(R_2) - R_f]$$
$$Z_1\sigma_{i1} + Z_2\sigma_{i2} + \cdots + Z_i\sigma_{ii}) = [E(R_i) - R_f]$$

The simultaneous equation can be simplified to get (Z_1) which is the weighing scale of an asset that will be used to get the proportion of funds to be invested in each asset in the portfolio by a formula.

$$Z_i = (E(R_i) - R_f)\frac{1}{\sigma^2_i}$$

Analysis of Investment Portfolio Performance

Lin and Chou (2003) [12] states that the Sharpe ratio calculation is expected to facilitate investors with different risk attitudes in determining investment choices for each investor. Furthermore, Nielsen and Vassalou (2004) [13] say that investments that have a higher Sharpe ratio allow investors to get additional higher investment returns. Sharpe ratio can be obtained by reducing the portfolio return rate with the risk-free rate of return. After the excess return value is obtained, then the excess return is divided by the standard deviation of the portfolio.

RESULTS AND DISCUSSION

Minimum Liquidity of PLN Pension Funds

The investment return in 1 year must be at least the same as the actuarial technical interest of the average total investment and can be done in the event of a forced event. The return on investment is set at 9.50%. Besides, the PLN Pension Fund must maintain a minimum investment portfolio liquidity to meet its obligations, at least 1.25% per month from the total investment.

Pension funds must always maintain the adequacy ratio of funds so that the funds are met. This is caused by the risk of funding lies with the employer who is fully responsible for funding. The employer should pay normal contributions and additional contributions, additional contributions are paid when the normal contributions from participants and the employer do not meet the adequacy ratio of funds in the current year determined or calculated by actuaries.

When the adequacy ratio of funds reaches more than 100%, it can be said that the pension fund is in a surplus, but if the adequacy ratio of the fund is less than 100%, it means that the pension fund is in a deficit condition, so that founders in addition to paying normal contributions are also required to pay additional contributions. However, when the adequacy ratio of funds can exceed 120% it can be used as a deduction from normal contributions. During the study period, the PLN Pension Fund has never reached a fund adequacy ratio exceeding 120%, but it is still in a fulfilled condition, except in 2018, where the PLN Pension Fund experienced a deficit with a fund adequacy ratio of 96.75%.

Return and Risk Analysis of PLN Pension Fund Portfolio

In carrying out investment activities during the study period, the PLN Pension Fund makes an investment allocation with the following composition.

Table 3: RiskandreturnonPLN'sPensionFundportfolio

Types of Assets	Weight	2015 (%)	2016 (%)	2017 (%)	2018 (%)	Average (%)
Government Securities	w_1	16,85	18,87	19,45	19,86	18,76
Time Deposits	w_2	12,23	8,18	9,22	5,11	8,69
Bonds	w_3	11,00	11,01	13,42	12,76	12,05
Stocks	w_4	42,80	45,32	42,14	46,32	44,14
Mutual Funds	w_5	17,12	16,61	15,77	15,95	16,36
Portfolio Return		7,83	8,18	8,47	8,65	8,26
Portfolio Risk		1,82	0,66	1,48	1,16	1,56

The portfolio return owned by the PLN Pension Fund is a fairly large returns but also has a large risk. The level of return on the PLN Pension Fund portfolio ranges from:
Lower limit = 8.26% - 1.56% = 6.70%
Upper limit = 8.26% + 1.56% = 9.83%

Performance Analyses of Each PLN Pension Fund Asset

1. Sharpe ratio

Table 4: The Sharperatioforeach PLN PensionFundassetsanditsbenchmarks

Sharpe Ratio				Performance
Assets		Benchmark		
Government Securities	7,129	IGBI	0,213	outperformed
Time Deposits	1,446	BI Reverse RR	-0,309	outperformed
Bonds	0,816	IHSG	-0,285	outperformed
Stocks	15,470	ICBI	7,351	outperformed
Mutual Funds	-3,185	IBFI	-1,638	underperformed

Bonds provide the highest Sharpe ratio, so that bonds can provide a greater investment return than other assets. Sharpe ratio calculation results when compared with the benchmark for each asset is that there is one asset that cannot match market performance (underperformed), namely mutual funds. While other assets have a good performance. This means that after considering the risk factors, the asset can exceed the market performance (outperformed).

2. Treynor ratio

Table5:The TreynorratioforeachPLN PensionFundassetsanditsbenchmarks

Treynor Ratio				Performance
Assets		Benchmark		
Government Securities	0,268	IGBI	0,003	outperformed
Time Deposits	0,005	BI Reverse RR	-0,000	outperformed
Bonds	0,347	IHSG	-0,009	outperformed
Stocks	-0,546	ICBI	0,016	outperformed
Mutual Funds	-0,358	IBFI	-0,034	underperformed

Bonds and Mutual Funds have a negative Treynor ratio value. In contrast to mutual funds, the negative Treynor value on bonds is caused by the beta owned by negative-marked bonds. So the value considered in decision making is an absolute value. Treynor ratio results when compared with the benchmarks for each asset, is that mutual funds can not match market performance (underperformed). While other assets can match market performance (outperformed), this is in line with the Sharpe ratio.

3. Jensen ratio

Table6:The Jensen ratioforeach PLN PensionFundassetsandexpected CAPM return

Assets	Average Return (1)	ExpectedReturn (CAPM) (2)	Jensen alpha (1)-(2)	Performance
Government Securities	0,090	0,059	0,032	Superior
Time Deposits	0,086	0,056	0,030	Superior
Bonds	0,085	0,058	0,027	Superior
Stocks	0,097	0,057	0,040	Superior
Mutual Funds	0,030	0,056	-0,025	Inferior

Bonds provide the highest Jensen alpha value, this is in line with the Sharpe ratio and Treynor ratio performance measurements. On the other hand, four assets have a positive Jensen alpha value. This means that fund managers can choose undervalued securities, the ability to predict the market, and the ability to respond to changes in the market. While mutual funds have negative alpha Jensen values which means they have inferior performance or do not have selectivity capabilities. This is in line with the performance measurements of the Sharpe ratio and Treynor ratio where mutual funds have suboptimal performance.

Analysis of Optimal Portfolio

The weight calculation results for each asset (Wi) in the portfolio use single-index model and tangency portfolio compared to the historical weights as follows.

Table 7: Comparison of the composition, risk, and return of the PLN Pension Fund portfolio with the single-index model and portfolio tangency

Types of Assets	Weight	Dana Pensiun PLN (%)	Single-Index Model (%)	Tangency Portfolio (%)
Government Securities	w_1	18,76	91,55	15,00
Time Deposits	w_2	8,69	0,00	5,01
Stocks	w_3	12,05	1,49	13,00
Bonds	w_4	44,14	0,00	66,99
Mutual Funds	w_5	16,36	6,96	0,00
Portfolio Return		8,26	9,05	9,41
Portfolio Risk		1,56	0,43	0,38

Based on the portfolio composition in Table 7, the limit on the return on single-index model portfolio will depend on the range:
Lower limit = 9.05% - 0.43% = 8.62%
Upper limit = 9.05% + 0.43% = 9.48%
While the limits on the return on tangency portfolio will depend on the range:
Lower limit = 9.41% - 0.38% = 9.02%
Upper limit = 9.41% + 0.38% = 9.79%

Performance Analysis of Optimal Portfolio

Assessment on the performance of the PLN Pension Fund portfolio and the portfolio produced by the single-index model and tangency portfolio using the Sharpe ratio as follows.

Table 8: Comparison of the Sharpe ratio of historical and proposed portfolio

	PLN Pension Fund	Proposed	
		Single-Index Model	Tangency Portfolio
PortfolioReturn(%)	8,26	9,05	9,41
Risk-Free Aset (%)	5,83	5,83	5,83
Excess Return (%)	2,43	3,22	3,58
Portfolio Risk (%)	1,56	0,43	0,38
Sharpe Ratio	1,55	7,51	9,48

Based on Table 8, the Sharpe ratio from the PLN Pension Fund portfolio has a lower value than the Sharpe ratio generated from the single-index model and tangency portfolio. On the other hand, portfolio performance results formed by the single-index model look better than the PLN Pension Fund portfolio, the portfolio composition produced by the single-index model is not following PLN's Pension Fund investment policy, the allocation of government bonds exceeds the maximum quantitative limit. Based on Table 7, the weight of government bonds is 91.55%, while the maximum quantitative value of the PLN Pension Fund is only 75.00%. The PLN Pension Fund can consider the tangency portfolio as an alternative to get the maximum return where the portfolio formed by the tangency portfolio has the highest Sharpe ratio value and has a portfolio composition based on the PLN's Pension Fund investment policy.

Managerial Implications

Managerial implications that can be considered by the PLN Pension Fund include.

1. Management can consider reducing allocations on mutual funds. Based on risk-adjusted performace, mutual funds have suboptimal performance compared to other assets.
2. The portfolio composition formed by the single-index model cannot be considered by management, because the resulting portfolio composition exceeds the quantitative limits of PLN's Pension Fund investments policy. Based on risk-adjusted performance, mutual funds have sub-optimal performance. This is in line with the composition generated by portfolio tangency, where mutual funds do not become optimal portfolio forming assets. So management can consider the portfolio formed by portfolio tangency as an alternative to getting the maximum return.
3. In Table 9, the assets of the PLN Pension Fund at the end of 2018 amounted to Rp. 7,999 billion. The proposed use of portfolio tangency has a risk of 0.38% so that investment returns are obtained with a lower limit of Rp. 723 billion and an upper limit of Rp. 783 billion. This indicates that if the PLN Pension Fund implements portfolio tangency, there is an excess return that can be generated from a managed

investment portfolio of Rp. 557 billion to Rp. 617 billion. The excess return calculation has assumed that the change in portfolio composition to portfolio tangency has reduced switching costs by 2.08% of total assets.

Table9:Comparison of tangency portfolio with historical portfolio In billions of Rupiah

	Net Assets	Return	Lower Limit and Upper Limit	Switching Cost (2,08%)	ExcessReturn
PLN Pension Fund	6.212	516	416 s/d 610	-	516
TangencyPortfolio	7.999	557 s/d 617	723 s/d 783	166	s/d 617

4. Changes in the composition of this portfolio will be a study for companies that will be taken to the investment committee meeting to get approval for changes in the composition of PLN's Pension funds.

CONCLUSION

1. Mutual funds have suboptimal performance based on risk-adjusted-performance. While government securities, time deposits, stocks, and bonds have good performance. In general, outperformed and superior conditions of the four assets show better conditions than the benchmark.
2. The PLN Pension Fund can use a portfolio composition with tangencyportfolio which has a lower risk level with a higher portfolio return than the PLN Pension Fund historical portfolio and the single-index model. Tangency portfolio composition is not much different from the composition of the historical PLN Pension Fund, where bonds are still the dominant portfolio-forming assets

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