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COMPARISON OF OPTIMAL PORTFOLIO PERFORMANCE USING CAPM AND BLACK-LITTERMAN MODEL WITH BAYES APPROACH

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ABSTRACT

Background: The significant increase in Single Investor Identification (SID) in 2020 (56.21%) and 2021 (92.99%) indicates that the Indonesian capital market is increasingly in demand. At that time, when many stock indices fell, IDX BUMN20 increased and even managed to compete with IDX LQ4. Thus, there is an opportunity to maximize returns by forming a new portfolio.
Purpose: This study aims to analyze the optimal portfolio using the CAPM and–k the Litterman model with the Bayes approach.
Design/methodology/approach: The optimal portfolio is evaluated using financial ratios, forecasting tests, and back testing tests.
Findings/Result: The optimal portfolio results with the CAPM method consist of ANTM shares (26%), BBRI (50%), PTBA (11%), and TINS (13%). The optimal portfolio results using the Black-Litterman method with the Bayes approach consist of ANTM shares (18%), BBRI (60%), PTBA (17%), and TINS (6%).
Conclusion: Based on the evaluation results, Black-Litterman with the Bayes approach has a higher overall financial ratio value than CAPM.
Originality/value (State of the art): Overall, the application of the latest data of the optimal portfolio shows that the Black–Litterman method with the Bayes approach is more optimal than CAPM. However, the composition of the optimal Black - Litterman portfolio using the Bayes approach must be recomposed periodically.

Keywords: bayes approach, Black – Litterman, CAPM, IDX BUMN20, optimal portfolio

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INTRODUCTION

The economic crisis of 2019, exacerbated by the COVID-19 pandemic, made many people realize the importance of investing. Passive income from investments is an alternative to economic crises. In 2020, public participation in the capital market significantly increased. This increase was marked by an increase in the number of new Single Investor Identification (SID) by 56.21%, and in 2021, there was an increase of 92.99% new SIDs, which is the highest recorded in the history of the Indonesian capital market (BEI, 2022).

In March 2020, several stock indices declined at the start of the COVID-19 pandemic. However, IDX BUMN20 experienced an increase; even in October 2020, BUMN shares showed the largest trading transaction value on the Indonesian Stock Exchange (BEI). In October 2020, BUMN shares had the largest trading transaction value in the IDX. The five shares with the largest trading transaction value on the IDX at the time were BBCA (IDR11.07 trillion), the BBRI (IDR9.38 trillion), and the TLKM (IDR8.67 trillion), and ANTM (IDR8.58 trillion) and BRIS (IDR7.86 trillion). Four of the five shares are BUMN shares, namely, BBRI, TLKM, ANTM, and BRIS. This shows that the IDX BUMN20 attracts more investor interest (Putra, 2020).

Based on data from the Indonesian Stock Exchange (BEI), the performance of IDX BUMN20 in 2020 was 0.4%, while IDX LQ45 was -7.8% in the same period (Wareza, 2021; BEI, 2021). Therefore, issuers of IDX BUMN20 have good prospects for choosing when investing in shares.

The IDX BUMN20 was formed using the capped market capitalization-weighted (CMCW) method, which is a passive portfolio. A passive investor feels satisfied with obtaining a good return by investing in IDX BUMN20. However, there is an opportunity for maximum returns if an active portfolio is formed based on issuers who are members of the IDX BUMN20.

This study compares the use of CAPM and BL model with the Bayes approach in forming optimal portfolios (shown at Table 1). Sharpe (1964), Lintner (1965), and Mossin (1966) proposed the CAPM model. The CAPM explains the relationship between systematic risk and expected returns for assets, especially shares. The CAPM explains that the return of an asset is only influenced by systematic risk because unique or unsystematic risks can be eliminated through diversification (Hendrawan, 2010). Stock beta value can improve the total risk in an investor's portfolio. Therefore, investors who invest capital in various types of shares are strongly advised to use the beta value to measure share ratio.

The BL model was proposed by Black and Litterman in 1990. The BL model combines market data with investors' views of expected future returns. This BL model processes information using Bayesian analysis to combine investor views with the results of market data calculations (Black and Litterman, 1992; Cheung, 2010; Subekti, 2009; Idzorek, 2007).

Based on this background, this research aims to form an optimal portfolio for issuers who are members of IDX BUMN20 using CAPM and then compare it with the BL model using the Bayes approach. The optimal portfolio was formed based on weekly historical data from January 2018 to December 2021. The optimal portfolio's performance was evaluated using three financial ratios: the Sharpe ratio, the Treynor measure, and Jensen's alpha. The Sharpe ratio accurately calculates the total risk of a portfolio to assess whether it is well differentiated. The Treynor measure assumes that a well-differentiated portfolio uses systematic risk. Jensen's alpha is a ratio that shows the difference between expected returns and portfolio returns (Verma and Hirpara, 2016). Next, a comparative analysis was performed between the methods using IDX BUMN20 as a benchmark. The portfolio that has been formed is also subjected to forecasting and backtesting tests. The forecasting test uses the latest data for January - April 2022 to determine whether the portfolio is relevant for use in the future. The backtesting test used historical data for the past four years from 2018 to 2021.

METHODS

The sample for this research comprises shares listed on IDX BUMN20 during the 2018–2021 period as shown in Table 2. Based on the IDX data, IDX BUMN20 changed its composition five times during the 2018–2021 period. Thus, there are 16 shares consistently listed on the IDX BUMN20 during the 2018 – 2021 period (Table 2). These shares are considered to have relatively large market capitalization and high liquidity compared with other BUMN shares. The historical data used are closing stock prices and weekly JCI for January 2018 – 2022.

This study uses Bank Indonesia Certificates (SBI) as risk-free assets or risk-free rates. The SBI interest rate follows the Bank Indonesia interest rate (BI rate). The BI rate is an interest rate represents Indonesia's monetary policy. Table 3 shows the BI rate values for the period from January 2018 to December 2021 used in this research.

Data on individual stock closing prices, stock market (JCI), and BI rate (7-days Repo-rate) are processed before creating optimal CAPM and Black – Litterman portfolios. The average return was calculated for each of these datasets. The results of these calculations are presented in the table below (Tables 4, 5, and 6).

Table 1 Comparison of CMCW, CAPM and Black – Litterman Models

Capped Market Capitalization Weighted	Capital Asset Pricing Model	Model Black – Litterman with Bayes Approach
Portfolio weights are based on market capitalization	Use the market beta coefficient to access risk	Involving investors views
The portfolio value changes proportionally	Eliminate unsystematic risk	Holistic approach
Very suitable for use in forming stock indices	Widely used by investors	Can increase profits without increasing the risks involved

Table 2 List of shares consistently listed on IDX BUMN20 for 2018 – 2021

Codes	Shares Name
ANTM	Aneka Tambang (Persero) Tbk
BBNI	Bank Negara Indonesia (Persero) Tbk.
BBRI	Bank Rakyat Indonesia (Persero) Tbk
BBTN	Bank Tabungan Negara (Persero) Tbk.
BJBR	Bank Pembangunan Daerah Jawa Barat dan Banten Tbk.
BMRI	Bank Mandiri (Persero) Tbk.
ELSA	Elnusa Tbk.
JSMR	Jasa Marga (Persero) Tbk.
PGAS	Perusahaan Gas Negara (Persero) Tbk.
PTBA	Tambang Batubara Bukit Asam Tbk
PTPP	PP (Persero) Tbk.
SMGR	Semen Indonesia (Persero) Tbk.
TINS	Timah (Persero) Tbk
TLKM	Telekomunikasi Indonesia (Persero) Tbk.
WIKA	Wijaya Karya (Persero) Tbk.
WSKT	Waskita Karya (Persero) Tbk.

Table 3 BI rate (7-days Repo-rate) for the period January 2018 – December 2021

Months	Year			
	2018	2019	2020	2021
January	4.25%	6.00%	5.00%	3.75%
February	4.25%	6.00%	4.75%	3.50%
March	4.25%	6.00%	4.50%	3.50%
April	4.25%	6.00%	4.50%	3.50%
May	4.75%	6.00%	4.50%	3.50%
June	5.25%	6.00%	4.25%	3.50%
July	5.25%	5.75%	4.00%	3.50%
August	5.50%	5.50%	4.00%	3.50%
September	5.75%	5.25%	4.00%	3.50%
October	5.75%	5.00%	4.00%	3.50%
November	6.00%	5.00%	3.75%	3.50%
December	6.00%	5.00%	3.75%	3.50%

Table 4 Average Individual Stock Returns for The Period January 2018 – December 2021

Codes	Shares Name	Individual Stock Returns
ANTM	Aneka Tambang (Persero) Tbk	0.00925
BBNI	Bank Negara Indonesia (Persero) Tbk.	-0.00034
BBRI	Bank Rakyat Indonesia (Persero) Tbk	0.00174
BBTN	Bank Tabungan Negara (Persero) Tbk.	-0.00108
BJBR	Bank Pembangunan Daerah Jawa Barat dan Banten Tbk.	-0.00150
BMRI	Bank Mandiri (Persero) Tbk.	0.00050
ELSA	Elnusa Tbk.	0.00077
JSMR	Jasa Marga (Persero) Tbk.	-0.00081
PGAS	Perusahaan Gas Negara (Persero) Tbk.	0.00147
PTBA	Tambang Batubara Bukit Asam Tbk	0.00201
PTPP	PP (Persero) Tbk.	-0.00168
SMGR	Semen Indonesia (Persero) Tbk.	0.00024
TINS	Timah (Persero) Tbk	0.00629
TLKM	Telekomunikasi Indonesia (Persero) Tbk.	0.00030
WIKA	Wijaya Karya (Persero) Tbk.	0.00119
WSKT	Waskita Karya (Persero) Tbk.	-0.00261

Table 5 Average Share Market Return for the January 2018 – December 2021 Period

Codes	Shares Market Name	Average of market return
IHSG	Indeks Harga Saham Gabungan	0.00047

Table 6 Results of Calculating the Average Return Risk Free Rate for the January 2018 - December 2021 Period

Risk-Free Asset Name	Average of Risk-Free Rate return
Certificate of Bank Indonesia	-0.0789%

The CAPM and Black-Litterman with Bayes approach portfolio formation methods were used in this study. CAPM relates the expected return rate of an asset to its risk in a balanced market condition. The beta variable was used as an indicator of risk measurement (Bodie et al. 2019). The Black-Litterman model starts from a neutral position using modern portfolio theory, namely CAPM, and then considers the investor's view to determine how the final asset allocation deviates from the initial portfolio weight (Black and Litterman, 1992). The optimal portfolio results are then evaluated using financial ratios, namely, the Sharpe ratio, Treynor measure, and Jensen's alpha, and then tested for forecasting and back-testing tests to determine the relevance of using the optimal portfolio.

This research is a quantitative study using secondary data from shares of companies listed in IDX BUMN20 during the 2018–2021 period. The data obtained are analyzed to form an optimal portfolio using CAPM and the Black - Litterman model with the Bayes approach. The optimal portfolio is then analyzed for its performance using the Sharpe ratio, Treynor measure, and Jensen's alpha. Forecasting and backtesting tests were then carried out on optimal portfolio use. Finally, a descriptive analysis is conducted regarding managerial implications, and conclusions are drawn. The flow of the framework used in this study is illustrated in Figure 1.

RESULTS

Capital Asset Pricing Model

The CAPM is relevant in research, especially in the fields of investment management, portfolio management, return, and risk. CAPM can be relied upon as a basis for decision-making in the academic, policy, and industrial fields related to fundamental investment models, contributes to the body of knowledge, and encourages evidence-based decision-making for stakeholders (Kumar et al. 2023).

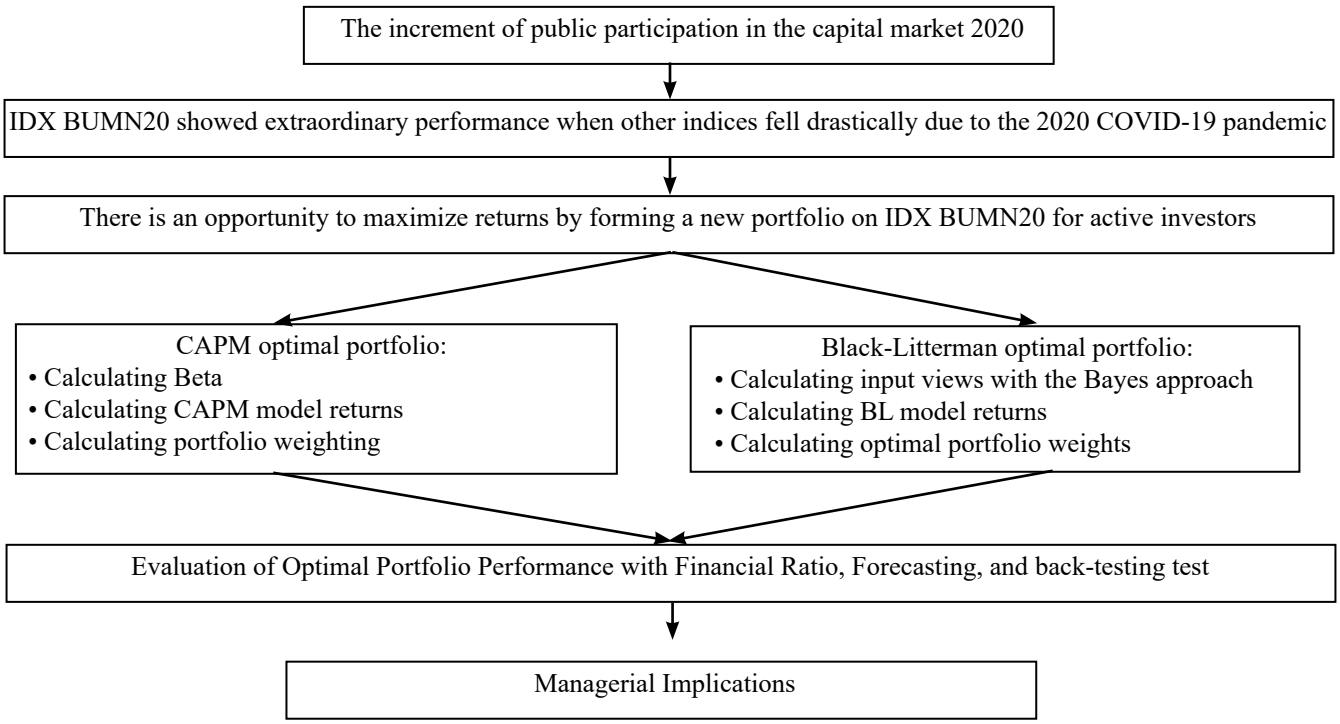

Figure 1. Research framework

CAPM uses beta as a risk measurement indicator. The beta variable evaluates a stock based on its volatility of one stock against the volatility of all markets (de Andrade Alves, 2023). This study calculates beta by comparing the return on the issuer's shares with the Composite Stock Price Index (JCI). A large beta value indicates that the stock is more sensitive or has a higher level of volatility than JCI. The results of the beta calculations in this study are presented in Table 7.

Most of the beta values for the sample issuers were above 1. There is only one issuer that has a beta value of less than 1 but is positive, namely, TLKM, which is worth 0.97. A beta value greater than one indicates that the issuer's share price has a level of volatility or price change above the market (JCI). A beta value that is less than 1 but positive indicates that the issuer's share price sensitivity is smaller than that of the JCI (Khoa, 2023).

In the next stage, after knowing the beta value of each sample issuer, the expected return is calculated based on the CAPM method. Return is the profit obtained from the investment. The return referred to in this study is the return value obtained as a result of investing in shares. The CAPM expected return calculation was performed to determine the estimated return from stock investments using the CAPM method (Smith, 2023). Table 8 presents the results of the expected return calculations in this study.

The next stage, after knowing the CAPM return, is to determine which shares are efficient and inefficient. Efficient shares have an average individual share return value greater than the CAPM expected return value. The results of determining efficient and inefficient shares are shown in Table 9. Thus, the efficient shares are ANTM, BBRI, PTBA, and TINS.

After determining which shares are efficient, the next stage is to calculate the residual variance error (σei^2) and excess return to beta (ERB) values presented at Table 10. ERB measures the excess return relative to a unit of risk that cannot be diversified as measured by beta. The ERB ratio indicates the relationship between returns and risk (Hartono, 2015). The ERB of a stock is obtained by subtracting the expected return value of a stock and the risk-free rate and then dividing it by the beta value of the stock.

Table 7. Results of Shares Beta (β) Calculations for the January 2018 – December 2021 Period

Codes	Shares Name	Beta (β)
ANTM	Aneka Tambang (Persero) Tbk	2.04
BBNI	Bank Negara Indonesia (Persero) Tbk.	1.73
BBRI	Bank Rakyat Indonesia (Persero) Tbk	1.47
BBTN	Bank Tabungan Negara (Persero) Tbk.	1.81
BJBR	Bank Pembangunan Daerah Jawa Barat dan Banten Tbk.	1.17
BMRI	Bank Mandiri (Persero) Tbk.	1.46
ELSA	Elnusa Tbk.	1.75
JSMR	Jasa Marga (Persero) Tbk.	1.31
PGAS	Perusahaan Gas Negara (Persero) Tbk.	1.97
PTBA	Tambang Batubara Bukit Asam Tbk	1.19
PTPP	PP (Persero) Tbk.	2.13
SMGR	Semen Indonesia (Persero) Tbk.	1.43
TINS	Timah (Persero) Tbk	2.00
TLKM	Telekomunikasi Indonesia (Persero) Tbk.	0.97
WIKA	Wijaya Karya (Persero) Tbk.	1.99
WSKT	Waskita Karya (Persero) Tbk.	2.20

Table 8. CAPM Expected Return Calculation Results

Shares	Beta (β)	Average Share Market Return	Average Return Risk Free Rate	Average Share Market Return - Average Return Risk Free Rate	β (Average Share Market Return - Average Return Risk Free Rate)	E(Ri)
ANTM	2.04	0.00047	-0.08%	0.00126	0.00256	0.00177
BBNI	1.73	0.00047	-0.08%	0.00126	0.00217	0.00138
BBRI	1.47	0.00047	-0.08%	0.00126	0.00185	0.00106
BBTN	1.81	0.00047	-0.08%	0.00126	0.00227	0.00149
BJBR	1.17	0.00047	-0.08%	0.00126	0.00147	0.00068
BMRI	1.46	0.00047	-0.08%	0.00126	0.00183	0.00105
ELSA	1.75	0.00047	-0.08%	0.00126	0.00220	0.00141
JSMR	1.31	0.00047	-0.08%	0.00126	0.00165	0.00086
PGAS	1.97	0.00047	-0.08%	0.00126	0.00248	0.00169
PTBA	1.19	0.00047	-0.08%	0.00126	0.00150	0.00071
PTPP	2.13	0.00047	-0.08%	0.00126	0.00268	0.00189
SMGR	1.43	0.00047	-0.08%	0.00126	0.00180	0.00101
TINS	2.00	0.00047	-0.08%	0.00126	0.00251	0.00172
TLKM	0.97	0.00047	-0.08%	0.00126	0.00122	0.00043
WIKA	1.99	0.00047	-0.08%	0.00126	0.00250	0.00171
WSKT	2.20	0.00047	-0.08%	0.00126	0.00276	0.00198

After determining the ERB calculation results for each stock, we determined the ranking of the ERB results starting from the largest to the smallest value. A negative ERB value is not included in the optimal portfolio formation because it still has a stock return below the risk-free rate of return (Terregrossa and Eraslan, 2016). The results show that the shares that have the largest ERB value are ANTM (Aneka Tambang (Persero) Tbk) shares of 0.00492, while the shares that have the smallest ERB value are BBRI (Bank Rakyat Indonesia (Persero) Tbk) shares of 0.00172.

Table 9. Determination of CAPM Efficient and Inefficient Shares

Codes	Shares Name	R_i	$E(R_i)$	Evaluation
ANTM	Aneka Tambang (Persero) Tbk	0.00925	0.00177	Efficient
BBNI	Bank Negara Indonesia (Persero) Tbk.	-0.00034	0.00138	Inefficient
BBRI	Bank Rakyat Indonesia (Persero) Tbk	0.00174	0.00106	Efficient
BBTN	Bank Tabungan Negara (Persero) Tbk.	-0.00108	0.00149	Inefficient
BJBR	Bank Pembangunan Daerah Jawa Barat dan Banten Tbk.	-0.00150	0.00068	Inefficient
BMRI	Bank Mandiri (Persero) Tbk.	0.00050	0.00105	Inefficient
ELSA	Elnusa Tbk.	0.00077	0.00141	Inefficient
JSMR	Jasa Marga (Persero) Tbk.	-0.00081	0.00086	Inefficient
PGAS	Perusahaan Gas Negara (Persero) Tbk.	0.00147	0.00169	Inefficient
PTBA	Tambang Batubara Bukit Asam Tbk	0.00201	0.00071	Efficient
PTPP	PP (Persero) Tbk.	-0.00168	0.00189	Inefficient
SMGR	Semen Indonesia (Persero) Tbk.	0.00024	0.00101	Inefficient
TINS	Timah (Persero) Tbk	0.00629	0.00172	Efficient
TLKM	Telekomunikasi Indonesia (Persero) Tbk.	0.00030	0.00043	Inefficient
WIKA	Wijaya Karya (Persero) Tbk.	0.00119	0.00171	Inefficient
WSKT	Waskita Karya (Persero) Tbk.	-0.00261	0.00198	Inefficient

Table 10. Residual Error Variance (σei^2) and Excess Return to Beta (ERB) using JCI

Codes	Shares Name	σei2	ERB
ANTM	Aneka Tambang (Persero) Tbk	0.00399	0.00492
BBRI	Bank Rakyat Indonesia (Persero) Tbk	0.00101	0.00172
PTBA	Tambang Batubara Bukit Asam Tbk	0.00225	0.00235
TINS	Timah (Persero) Tbk	0.00445	0.00354

The next stage determines the weight of each stock in the portfolio. Determining the investment weight aims to obtain the optimal portfolio. Calculate the cutoff point (Ci) first as a limiting point, and then calculate the unique cutoff point (C*), which is the optimal value of Ci. The C* value is used to determine the limiting point at which shares are considered optimal portfolio candidates. The results of calculating the unique cutoff point (C*) values are shown in Table 11.

Next, the weighted scale or weighting scale for each share (Zi) is calculated by dividing the beta of share-*i* by the residual error variance and then multiplying by the reduction in the ERB value and cut-off point C*). The proportion of funds (Wi) is calculated by dividing the Zi value by the sum of the Zi values. The results of determining the investment weights are listed in Table 12. Based on Table 12, it can be seen that the optimal portfolio for IDX BUMN20 based on the CAPM method consists of 26% ANTM shares, 50% BBRI shares, 11% PTBA shares, and 13% TINS shares.

Black–Litterman Model with Bayes Approach

The Black – Litterman model is an approach used in portfolio management and investment analysis to combine market views with individual views to obtain optimal portfolio allocation. The Black – Litterman model aims to improve estimates of stock returns and risks by involving additional information available from investors' views. Thus, this method tries to combine investors' views with information drawn from market data to create a more efficient portfolio. This approach makes it possible to create a portfolio that is tailored to investors' goals and risk tolerance (Martin, 2019).

The Black – Litterman model combines two expected return values based on the CAPM expected return and the expected return based on investors' views. Investors' views are illustrated in a mathematical model so that they can be considered. The combination of these two expected returns produces a new expected return value, called the Black Litterman expected return. The Black – Litterman method in this study uses the Bayes

approach to combine the Black – Litterman model probability distribution (Bayram et al. 2018).

The Black – Litterman model with the Bayes approach uses investors' views to solve the equilibrium expected return. There are two types of investor views on this matter: relative and absolute. An investor views an issuer based on an analysis of market, economic, political, and state conditions, which are variables that influence stock movements. Investors have a risk profile that influences their views on an issuer. The higher the risk level of an investment instrument, the higher the return generated. There are three types of investor risk profiles: investors who like risk (risk seekers), neutral investors (risk neutrality), and investors who do not like risk (risk averters) (Subekti et al. 2019).

In this study, the researcher acts as an investor with a subjective opinion about a stock based on fundamental stock analysis. The researchers chose four shares from the CAPM portfolio results, namely, ANTM, BBRI, PTBA, and TINS, to compile an optimal Black Litteran portfolio using the Bayes approach. An investor's view certainly contains uncertainty; therefore, it is necessary to measure their confidence level (Walters, 2014). Researchers predict the return of a stock in the future by analyzing stock price movements and comparing them stock price movement to other shares based on previous stock prices and existing economic conditions. Returns data of the selected stoks in Table 13.

The following is an investor's view of using the Bayesian approach to these four shares:
Views1 : "ANTM will provide a return of 0.22% greater than PTBA"
Views2 : "BBRI will provide a return of 0.13% less than TINS"
Views3 : "PTBA will provide a return of 0.35% less than BBRI"
Views4 : "TINS will provide a return of 0.26% greater than ANTM"

Based on these four views, the following matrix equation can be formed:

$$P = \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & -1 & 0 & 1 \\ 0 & 1 & -1 & 0 \\ -1 & 0 & 0 & 1 \end{bmatrix}; \pi = \begin{bmatrix} 0.0124 \\ 0.0137 \\ 0.0102 \\ 0.0149 \end{bmatrix};$$

$$Q = \begin{bmatrix} 0.0022 \\ 0.0013 \\ 0.0035 \\ 0.0026 \end{bmatrix}; \Omega = \begin{bmatrix} 1.2642 & 0.51337 & 0.38680 & -0.36404 \\ 0.51337 & 1.25013 & -0.37149 & 0.36528 \\ 0.38680 & -0.37149 & 0.73699 & -0.02130 \\ -0.36404 & 0.36528 & -0.0213 & 0.70802 \end{bmatrix}$$

After determining the views, the next stage is to calculate the matrix, Black–Litterman's expected return, and portfolio weights as follows:

$$E(r) = [(\tau S)^{-1} + P^T \Omega^{-1} P]^{-1}[(\tau S)^{-1}\pi + P^T \Omega^{-1} Q\,]$$

$$E(r) = \begin{bmatrix} 0.73960 & 0.31815 & 0.43847 & 0.67992 \\ 0.31815 & 0.42140 & 0.30836 & 0.34077 \\ 0.43847 & 0.30836 & 0.47795 & 0.44551 \\ 0.67993 & 0.34077 & 0.44551 & 1.00673 \end{bmatrix} \begin{bmatrix} 0.00095 \\ 0.03032 \\ -0.00478 \\ 0.00604 \end{bmatrix} = \begin{bmatrix} 0.01236 \\ 0.01367 \\ 0.01018 \\ 0.01493 \end{bmatrix}$$

Table 11. Results of Calculating the Unique Cut Off Point (C*) Value

Codes	Shares Name	Ai	Bi	Cum Ai	Cum Bi	Ci	C*
ANTM	Aneka Tambang (Persero) Tbk	0.850193	1046.528	0.850193	1046.528	0.000309	0.000704
BBRI	Bank Rakyat Indonesia (Persero) Tbk	2.190035	2132.102	3.040228	3178.63	0.000623	
PTBA	Tambang Batubara Bukit Asam Tbk	0.725387	623.0352	3.765615	3801.665	0.000684	
TINS	Timah (Persero) Tbk	0.74045	896.5123	4.506065	4698.178	0.000704	

Table 12. Results of Determining CAPM Investment Weights

Codes	Shares Name	Zi	Wi	%Wi
ANTM	Aneka Tambang (Persero) Tbk	1105.506	0.257991	26%
BBRI	Bank Rakyat Indonesia (Persero) Tbk	2150.513	0.501864	50%
PTBA	Tambang Batubara Bukit Asam Tbk	457.9829	0.106879	11%
TINS	Timah (Persero) Tbk	571.049	0.133265	13%

Based on Table 14, the optimal portfolio for IDX BUMN20, based on the Black – Litterman method with the Bayes approach, consists of 18% ANTM shares, 60% BBRI shares, 17% PTBA shares, and 6% TINS shares.

Optimal Portfolio Evaluation

An optimal portfolio evaluation is carried out by measuring portfolio performance. Measuring portfolio performance is not only seen from the portfolio return but also from the portfolio risk. The portfolio performance measurement in this research uses three financial ratios: the Sharpe ratio, the Treynor measure, and Jensen's Alpha; presented in Table 15. The Sharpe ratio evaluates portfolio performance based on the level of return against the total risk. The higher the Sharpe ratio value, the better is the portfolio performance. The Treynor measure evaluates portfolio performance under the assumption that a well-diversified portfolio uses systematic risk. Jensen's alpha shows the difference between portfolio returns and expected returns (Kandi V. S. et al. 2022).

Based on these results, the three largest portfolio performance ratios are portfolios produced using the Black – Litterman method. A Sharpe ratio value greater than 1 is generally considered acceptable by investors. If the Sharpe ratio is greater than 2, it is considered very good; if it is greater than 3, it is considered excellent; and if the Sharpe ratio value is smaller than 1, it is considered less than optimal. Thus, the optimal CAPM portfolio has excellent Sharpe ratio performance (Gupta and Chaudhary, 2023).

The treynor ratio is a risk-adjusted risk measurement that is based on systematic risk. The Treynor ratio shows the investment returns from a stock portfolio traded on the exchange. Systematic risk here refers to risks that cannot be avoided through portfolio diversification because they are directly related to the market. The higher the Treynor ratio, the better the relative performance of the portfolio, because it produces a higher return per unit of systematic risk (Kumar and Singh, 2022).

Table 13. Returns data of the selected stoks

Codes	Shares Name	Actual Return	Rf returns	CAPM Returns	Implied Returns	Historical Excess Returns	CAPM Excess Returns	Implied Excess Returns
ANTM	Aneka Tambang (Persero) Tbk	0.0092	-0.0008	0.0018	0.0216	0.0100	0.0075	0.0124
BBRI	Bank Rakyat Indonesia (Persero) Tbk	0.0017	-0.0008	0.0011	0.0154	0.0025	0.0007	0.0137
PTBA	Tambang Batubara Bukit Asam Tbk	0.0020	-0.0008	0.0007	0.0122	0.0028	0.0013	0.0102
TINS	Timah (Persero) Tbk	0.0063	-0.0008	0.0017	0.0212	0.0071	0.0046	0.0149

Table 14. Black – Litterman optimal portfolio calculation results

Shares	Shares Name	Varian	Expected Return BL	Portfolio Weight
ANTM	Aneka Tambang (Persero) Tbk	0.00643	0.01236	18%
BBRI	Bank Rakyat Indonesia (Persero) Tbk	0.00228	0.01367	60%
PTBA	Tambang Batubara Bukit Asam Tbk	0.00308	0.01018	17%
TINS	Timah (Persero) Tbk	0.00680	0.01493	6%

Table 15. Portfolio evaluation calculation results

	Portfolio Return	Sharpe Ratio	Treynor Measure	Jensen's Alpha
IDX BUMN 20	0.10%	0.59435	0.00107	0.00389
CAPM	0.13%	3.98672	0.00126	0.00419
Black-Litterman	1.29%	6.75589	0.00884	0.01569

Jensen's alpha calculates portfolio performance as the difference between the actual return generated by the portfolio and the expected return of the portfolio at a certain level of systematic risk. Systematic risk is influenced by premium risk (Rm–Rf); therefore, the greater the risk premium, the greater the value of systematic risk. If Jensen's alpha value is positive, then the portfolio is considered to have superior performance in the market. If Jensen's alpha value is negative, then the portfolio is considered to have inferior performance in the market. If the value of Jensen's alpha is zero, then the portfolio is risk-adjusted (Ruschelle, 2023).

Forecasting Test

Forecasting tests are performed by predicting future trends based on historical data. This also helps assess how well the portfolio performs. Thus, this forecasting test aims to ensure that the predictions are in line with actual observations, and to perfect or select the most effective optimal portfolio model (Subekti et al. 2021). The forecasting test was carried out using the latest data for four months from January to April 2022. The results of the forecasting test calculations using the latest four months of data are presented in Table 16.

If we viewed from the average portfolio return value during the period January - April 2022, IDX BUMN 20 produced the lowest average portfolio return value, which is -0.05%; CAPM produced an average portfolio return value that was higher than IDX BUMN20 but lower than the Black-Litterman portfolio with the Bayes approach, which was 0.78%; the highest average portfolio return value was the Black-Litterman portfolio with the Bayes approach, which was 0.87%. Overall, the choice between Black-Litterman and CAPM depends on the investor's specific needs and situations. Black-Litterman is often considered preferable in situations where the investor's view can significantly improve portfolio returns, while the CAPM provides an important framework for a basic understanding of risk and return (Black and Litterman, 1992; Cheung, 2010; Subekti, 2009; Idzorek, 2007).

Backtesting Test

The optimal portfolio that has been formed is then backtested to determine the returns generated using historical data for the past four years in the 2018–2021 period. The backtesting test in financial analysis is used to test the effectiveness of an investment strategy by applying it to historical data. The backtesting test aims to determine how the optimal portfolio that has been formed will perform if applied in the past. Positive results from the backtesting test indicate that the portfolio may also be effective in the future (Silwal and Giri, 2024).

The results show that the use of the optimal CAPM and Black-Litterman portfolios with the Bayes approach produces higher returns than IDX BUMN20. The optimal Black-Litterman portfolio with the Bayes approach is not always superior to CAPM, and vice versa. This can be caused by the investor's view used in this calculation being the investor's view in the future; therefore, it is not relevant if applied in the past. This also shows that the use of the CAPM portfolio is relevant to the use of historical and current data. The use of the CAPM method portfolio is more sustainable than the Black-Litterman with the Bayes approach because the Black-Litterman with the Bayes approach combines investor views on current conditions only, which are subjective, while CAPM uses historical data. This study shows that investor views using the Black-Litterman method with the Bayes approach can significantly improve portfolio results (Table 17). However, the optimal portfolio composition needs to be recomposed periodically, because current investor views are not always relevant in the long term. The researcher suggests recomposing the portfolio once per year.

Table 16. Comparison of IDX BUMN20 Portfolio Returns, CAPM, and Black-Litterman with the Bayes approach for the period January – April 2022

	Jan-22	Jan - Feb 2022	Jan - Mar 2022	Jan - Apr 2022	Average
IDX BUMN 20	-0.63%	0.07%	0.17%	0.19%	-0.05%
CAPM	-1.27%	1.74%	1.37%	1.29%	0.78%
Black-Litterman	-0.81%	1.76%	1.28%	1.27%	0.87%

Table 17. Comparison of IDX BUMN20 Portfolio Returns, CAPM, and Black-Litterman with the Bayes approach for the period 2018 - 2021

	2018	2019	2020	2021
IDX BUMN20	0.11%	-0.11%	0.44%	-0.09%
CAPM	0.37%	0.37%	0.84%	0.25%
Black-Litterman	0.41%	0.31%	0.58%	0.18%

Managerial Implications

The managerial implications of this study are intended for stock investors, especially those who invest in BUMN stocks. An investor is not free from risk; therefore, the formation of a stock portfolio is an alternative to reduce risk. Stock portfolio formation is a diversification activity that allocates a certain amount of funds to several issuers. The portfolio formed is first tested using historical data to determine whether the expected return is in accordance with reality.

The results of this study indicate that the optimal portfolio generated by the Black-Litterman method with the Bayes approach generally provides a greater return than the CAPM portfolio. However, neither portfolio is free of negative returns. CAPM relates the expected return rate of an asset to its risk in balanced market conditions, with the beta variable used as an indicator of risk measurement. Black-Litterman allocates assets optimally with risk tolerance and investors' views on the market. Overall, the selection of the optimal portfolio formation method depends on investors' needs. This study shows that investors' views can significantly improve portfolio results. The average portfolio return for four months shows that the Black-Litterman portfolio generates a return of 0.09% greater than the CAPM portfolio and a return of 0.92% greater than the IDX BUMN20 return. Thus, the optimal portfolio from this study can be an alternative for investors, especially those who want to invest in BUMN stocks.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the results of the analysis of optimal portfolio formation using the CAPM and Black - Litterman methods with the Bayes approach, optimal portfolio for IDX BUMN20 using CAPM on data for the period January 2018 to December 2021 resulted in an optimal portfolio consisting of ANTM shares (26%), BBRI (50%), PTBA (11%), and TINS (13%). The optimal portfolio evaluation produced by the CAPM has a financial performance Sharpe Ratio of 3.98672, Treynor Ratio of 0.00126, and Jensen's alpha of 0.00419. Whilst The optimal portfolio using Black – Litterman Model with the Bayes Approach consists of ANTM shares (18%), BBRI (60%), PTBA (17%), and TINS (6 %). The optimal portfolio evaluation produced using the Black – Litterman Model method with the Bayes Approach has a Sharpe Ratio of 6.75589, Treynor Ratio of 0.00884, and Jensen's alpha of 0.01569.

A comparison of the performance of the CAPM and Black – Litterman portfolios with the Bayes Approach based on the Sharpe Ratio, Treynor Ratio, and Jensen's alpha shows that both have very good performance. However, Black – Litterman with the Bayes Approach overall has a higher financial ratio value than CAPM. Thus, the performance of the Black – Litterman Model portfolio using the Bayes Approach is more optimal than that of the CAPM. The Forecasting Test shows that the return predictions produced by the Black – Litterman model with the Bayes Approach are closer to the actual return value than the CAPM. The backtesting Test shows that the Black – Litterman optimal portfolio composition with the Bayes Approach needs to be recomposed periodically, because the current investor's view is not always relevant in the long term. Researchers have suggested recomposing the portfolio once a year.

Recommendation

The optimal portfolio formation method using the Black – Litterman model with the Bayes approach is recommended for investors more than the CAPM method. The Black - Litterman method with the Bayes approach involves investors' views on investing to produce more relevant return predictions. Suggestions for further research include exploring the application of the Black - Litterman method to form an optimal portfolio. Apart from the Bayes approach, the development of the portfolio formation Black - Litterman method can be applied with other approaches such as Least Discriminant, sampling, and Theil Mixed.

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