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USE OF THE BLACK-LITTERMAN MODEL IN PORTFOLIO OPTIMIZATION FOR ACTIVE INVESTORS ON STOCKS IN LQ45 INDEX

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ABSTRACT
In these modern era, it is very easy to create an investment portfolio, an investment portfolio can be formed by buying a shares. By creating portfolio investation, our can expect score return which makes it an advantage. However, there is also a risk value that will be obtained when buy shares. In the formation of an investment portfolio for active investors, it is expected to create an optimal investment portfolio, there are many models that can be used to create an optimal investment portfolio. In this final project, will discusses the use of the Black-Litterman Model in optimizing portfolios for active investors. The Black-Litterman model is one of the models that can be used to optimize the investment portfolio, the Black-Litterman model provides additional information for the return and risk values based on the views of experts. This model builds on the MV and CAPM using a Bayesian framework that allows investors to effectively incorporate their views of the market into the allocation process asset. Based on several tests that have been carried out during the research with different days, the value of the investor's view will always be different every day, the value of an optimistic view will have a good impact on the stock, even though the stock price is falling, if the investor's view is expressed optimism, the weight of the shares will remain high.

I. INTRODUCTION

AN investment is portfolio is the ownership of stocks, bonds, or other financial assets with the hope of gaining profits or increasing the value of their assets over time, or even both [2]. When will create an investment portfolio, resources is needed [2]. Portfolio management for active investors relies on a precise estimate of asset characteristics, such as risk and return [1].

Black-Litterman Model, is a method construction advanced which is used to overcome portfolio problems that are not intuitive, not concentrated, input sensitivity problems, and errors in maximizing estimates created by Fischer Black and Robert Litterman [3]. The *Black-Litterman* portfolio model provides additional information for the value of return and risk value for portfolio management made by experts, as well as targeting more precise estimates of market changes [1]. The *Black-Litterman model* considers historical data on asset returns using the classical model of Mean Variance (MV) and additional information generated by expert views on asset returns [1]. BLM was first introduced in Black and Litterman (1990) then explained more carry on in Black and Litterman (1991) and Black and Litterman (1992) regarding the asset allocation model which has roots on model optimization *mean-variance* (MV) and model determination price capital assets (CAPM) [3]. Contribution main from *Black-Litterman* Model is to enable investors to build an incoming portfolio reasonable and reflect their views on the market [3].

The development of investment in Indonesia is getting bigger, marked by the increasing number of securities companies that facilitate and invite the Indonesian people to be more familiar with stocks and teach all things related to stocks with the aim of forming young potential investors and with the existence of prospective investors and investors who have been formed, it is hoped that they can help in building economic growth in Indonesia for the better [17]. There have been many studies related to portfolio optimization such as the research in paper [17] which performs portfolio optimization using the Markowitz model. In that study using 25 stock data contained in the IDX30 index and concluded that there are 6 best stocks for portfolio optimization, namely, ADHI at 9.57 percent, BBCA at 28.92 percent, LPKR at 6.20 percent, SCMA at 18.99 percent, TLKM at 25.38 percent, and UNVR by 10.94 percent. The Markowitz model itself is suitable for investors who do not like high risk.

Another portfolio optimization research was conducted by Nhat NGUYEN. Trung NGUYEN. Sir TRAN. An

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MAI [8]. In that research comparing the shrinkage model and the SCM model on the paper in this study, it can be concluded that the shrinkage model has better results than the SCM model with the return value in that period being an average of 17.2% and for the SCM model itself it only has an average of 10.28 %.

In research [7] the test was only carried out 1 time, so there is no comparison whether when the stock value is down but the investor view is optimistic, the weight of the stock will decrease or it will increase or not change. In research [7] also, in determining investor views value is only relative and does not carry out systematic calculations.

In this final project, will discusses portfolio optimization using Black-Litterman model. There are lots of algorithm that can be used to optimize investment portfolio. In research [5] it is stated that the Black-Litterman model has advantages because it includes the view of investors, in this case investors have their own views when making investments. An active investor is someone who makes an active investment, an active investors aim to beat the average return on the stock market by taking advantage of short-term price fluctuations in order to get full profit [14]. While a passive investor mean someone who invests passively, it aims to invest in the long term [14]. Passive investors will limit the amount of buying and selling in portfolio [14].

II. RESEARCH METHODOLOGY

This research used for optimize portfolio investment for active investors using Black-Litterman Model. In optimize portfolio there are several stages, collecting data, calculate return value, calculate stock weight with Black-Litterman model, testing return portfolio, and make portfolio allocation. An overview of the system built during the research can be seen in Figure 1.`

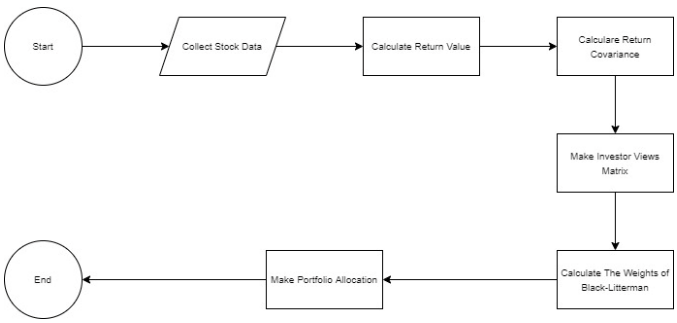

Figure 1. Flowchart System

A. *Stock Collection*

The first stage of this research is stock collection, stock that used in this research are BBCA.JK and TLKM.JK. Stock data can be collected from yahoo finance. Stock collection start from 3rd July 2018 until 27th June 2022 with 1 week interval. In this research only use adj close value from each stock. The data collection can be seen in Table I.

TABLE I
STOCK DATASET

Date	BBCA.JK	TLKM.JK
2018-07-02	3909.208496	3327.466553
2018-07-09	4301.530273	3465.392578
2018-07-16	4315.542969	3439.531494
…….	…….	……
2022-06-13	7350.000000	4080.000000
2022-06-20	7625.000000	4040.000000
2022-06-27	7350.000000	4070.000000

Besides of the value of adj close from each stock, the market capitalization weight of each assets is also required. The market capitalization from the assets also can be collected from yahoo finance. And to get the value of each market capitalization weight, the equation below is needed :

$$W_{mxy} = \left[\frac{market\ capitalization_{xy}}{Market\ capitalization_x + Market\ capitalization_y}\right] \quad (1)$$

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B. Calculate Return Value

Return value is the level of profits enjoyed by investors for an investment [15]. Stock return are income earned by shareholders as a result of their investment in certain companies [15]. In this research, the returns value of each assets that already collected can be calculate using this equation below :

$$\text{Return} = [\frac{Current\ value}{initial\ value}] - 1 \quad (2)$$

C. Calculate *Return* Covariance Matrix

Covariance matrix is estimated from historical data available up to a given date, optimal portfolio weights are computed from this estimate, then the portfolio is formed on that date and held until the next rebalancing occurs[16]. Return covariance can be calculated using return value data using this equation :

$$\text{Covariance} = [\frac{\sum(Return_{abc} - Average_{abc}) * (Return_{xyz} - Average_{xyz})}{(Sample\ Size) - 1}] - 1 \quad (3)$$

Where :
X_i = a given x value in the data set.
X_m = the mean, or average, of the x values.
Y_i = the y value in the data set that correspondends with Xi.
Y_m = the mean, or average, of the y values.

D. Make *Investor* Views Matrix

Investor views matrix is a value entered by investors to express investor views about the stock In this research, the value of investors views can be gained by analysis the stock movement using MA20 and MA50, MA10, and MA100 in Ajaib.com. An example of the investor views value can be seen in Table II.

TABLE II
VALUE OF INVESTORS VIEW

	View 1	View 2	View 3
BBCA.JK	0.1	-0.1	0.1
TLKM.JK	0.1	0.1	-0.1

Description :
0.1 = the view is optimist.
-0.1 = the view is pessimist.
View 1 = based on stock movement with MA20 and MA50.
View 2 = based on stock movement with MA10.
View 3 = based on stock movement with MA100.

E. Calculate the *Weights* of Black-Litterman

Black-litterman model is a model that can use to optimize portfolio investment[3]. This model builds on the MV and CAPM using a Bayesian framework that allows investors to effectively incorporate their views of the market into the asset allocation process[3]. Market equilibrium returns in needed as a starting point. The equilibrium returns vector is obtained with equation below :

$$\prod = \lambda \sum W_m \quad (4)$$

Where :
$\prod$ = implied excess equilibrium return vector
$\sum$ = NxN covariance matrix
λ = risk aversion
W_m= market capitalization weight of assets

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After calculate the value of implied excess equilibrium return vector, the next step is calculate expected returns itself using Black-Littterman model for each assets using the equation below :

$$E(R) = [\tau\sum)^{-1} + P^T\Omega^{-1}P]^{-1}[(\tau\sum)^{-1}\prod + P^T\Omega^{-1}Q\ ] \quad (5)$$

Where :
E(R) = Nx1 vector of expected returns, where N is the number of assets.
Q = Kx1 vector views.
P = KxN picking matrix
Ω = KxK uncertainly matrix views
∏ = Nx1 implied excess equilibrium return vector
∑ = NxN covariance matrix
τ = tuning constant

With the value of expected return, the last thing to do is calculate the weight of each assets using this equation below :

$$W= (\delta\sum)^{-1}E(R) \quad (6)$$

Where :
W = weights of assets
δ = risk aversion
E(R) = Nx1 vector of expected returns, where N is the number of assets.

F. Make *Portfolio* Allocation

In this portfolio allocation research, the test with the assumption that investors have money worth Rp.10.000.000,- which will be bought for shares. The allocation is based on each weight of the stock. The outcome is how much we will buy BBCA and TLKM shares, as well as the rest that is not used to buy shares.

III. RESULTS AND DISCUSSION

In this research, focusses on the formation of an optimal portfolio, by buying BBCA.JK and TLKM.JK shares. This portfolio optimization uses the Black-Litteman model. The test scenario is doing by testing the result of weight and portfolio allocation from 13 June 2022 to 27 June 2022 with 1 week interval by using stock data since 3 july 2018.

A. Test scenario 1

Test scenario 1 is done by calculating the weights of each stock using data from 3 july 2018 until 13 june 2022, which mean will get the result at that time, how much we should buy BBCA.JK shares and TLKM.JK shares based on the weights of each stocks.

The first thing to do, the return value and return covariance is needed, The return value and return covariance from each stocks can be seen in Table III.

TABLE III
RETURN VALUE AND RETURN COVARIANCE

	BBCA.JK	TLKM.JK
Return value	0.020408	0.062362
Return covariance	0.001149	0.000775

After return value and return covariance are obtained, the next step is to calculate the excess equilibrium return using the return covariance, risk aversion and the market capitalization weight. The value of risk aversion is 0.815475352017264 and the market capitalization for BBCA.JK and TLKM are 0.6873865577621183 and 0.3126134422378817. By using those data value of excess equilibrium can be obtained. The value of excess equilibrium from each stocks can be seen in Table IV.

TABLE IV
EXCESS EQUILIBRIUM

	BBCA.JK	TLKM.JK
Excess equilibrium	0.020789	0.020712

Right after done calculate the excess equilibrium value for each stock, the next step is to calculate the expected return by using the Black-Litterman model. In Black-Litterman a new variable is added namely investor views in making an expected return value. There will be 3 investor views in this test. The investor views value of that time can be seen in Table V.

TABLE V
INVESTOR VIEWS MATRIX

	View 1	View 2	View 3
BBCA.JK	-0.1	-0.1	-0.1
TLKM.JK	-0.1	-0.1	-0.1

With the investor views matrix, the expected return of Black-Litterman model can be calculated. The value of expected return of Black-Litterman model from each stocks can be seen in Table VI.

TABLE VI
EXPECTED RETURN OF BLACK-LITTERMAN MODEL

	BBCA.JK	TLKM.JK
Expected return of black-litterman model	0.000755	0.000670

Right after the expected return of Black-Litterman model is acquired, the weights of each stock can be calculated. The weights of each stocks can be seen in Table VII.

TABLE VII
WEIGHTS OF STOCK

	BBCA.JK	TLKM.JK
Weight	0.69711	0.30289

And for the last step after the weights of each stock is obtained, the portfolio allocation can be done. The assumption is the investor have funds of Rp.10.000.000, -. And the allocation will be like this based on the stock prices. The portfolio allocation can be seen in Table VIII.

TABLE VIII
PORTFOLIO ALLOCATION

	BBCA.JK	TLKM.JK
Total shares	948	743

With a fund of Rp. 10,000,000, 948 BBCA.JK shares will be purchased at a price of Rp. 6,967,800.- and 743 TLKM shares at a price of Rp.3.031.440,- and will leave funds of Rp.760.

B. Test scenario 2

Test scenario 2 is done by calculating the weights of each stock using data from 3 july 2018 until 20 june 2022. The steps to be taken are the same as in test scenario 1, what will be different are the values of the variables, such as return value, return covariance, excess equilibrium, expected return of Black-Literman model, stock weights and portfolio allocation. The value of return value, return covariance, excess equilibrium, expected return of Black-Litterman model and weights of each stocks can be seen in Table IX.

TABLE IX
TEST SCENARIO 2 VARIABLES

Date	BBCA.JK	TLKM.JK
Return value	-0.003333	0.007282
Return covariance	0.001146	0.000570
Excess qeuilibrium	0.020689	0.020624
Expected return of black-litter-man model	0.000655	0.000581
Weight	0.69858	0.30142

The value of matrix investor views are still same because the stock movement still pessimist based on MA20 & MA 50, MA10, and MA100. The investor views value of that time can be seen in Table X.

TABLE X
INVESTOR VIEWS MATRIX

	View 1	View 2	View 3
BBCA.JK	-0.1	-0.1	-0.1
TLKM.JK	-0.1	-0.1	-0.1

Based on the variables that have been obtained, the allocation of funds can be done, here are the results. The portfolio allocation can be seen in Table XI.

TABLE XI
PORTFOLIO ALLOCATION

	BBCA.JK	TLKM.JK
Total shares	916	746

With a fund of Rp. 10,000,000, 916 BBCA.JK shares will be purchased at a price of Rp. 6.984.500.- and 746 TLKM shares at a price of Rp. 3.013.840, - and will leave funds of Rp.1.660.

C. Test scenario 3

Test scenario 3 is done by calculating the weights of each stock using data from 3 july 2018 until 27 june 2022. The steps to be taken are the same as in test scenario 1 and 2, what will be different are the values of the variables, such as return value, return covariance, excess equilibrium, expected return of Black-Literman model, stock weights and portfolio allocation. The value of return value, return covariance, excess equilibrium, expected return of Black-Litterman model and weights of each stocks can be seen in Table XII.

TABLE XII
TEST SCENARIO 2 VARIABLES

Date	BBCA.JK	TLKM.JK
Return value	-0.016722	0.062362
Return covariance	0.001142	0.000571
Excess qeuilibrium	0.020779	0.020706
Expected return of black-litter-man model	0.000745	0.000664
Weight	0.69719	0.30281

In the third test scenario, there is a difference in the value in the third view, third views is optimistic because based on the movement of stocks using the MA100 line, the stocks is above the MA100 line. The investor views value of that time can be seen in Table XIII.

TABLE XIII
INVESTOR VIEWS MATRIX

	View 1	View 2	View 3
BBCA.JK	-0.1	-0.1	0.1
TLKM.JK	-0.1	-0.1	0.1

Based on the variables that have been obtained, the allocation of funds can be done, here are the results. The portfolio allocation can be seen in Table XIV.

TABLE XIV
PORTFOLIO ALLOCATION

	BBCA.JK	TLKM.JK
Total shares	949	743

With a fund of Rp. 10,000,000, 949 BBCA.JK shares will be purchased at a price of Rp. 6.975.150.- and 743 TLKM shares at a price of Rp. 3.024.010,- and will leave funds of Rp.840.

There is research related to portfolio optimization using the Black-Litterman model in the paper [13]. This study uses data on shares of BBNI, GGRM, and ICBP with a time period of 7 August 2013 to 7 October 2013. On the weighting of each share, BBNI shares get a higher value than GGRM shares, BBNI's weight is "0.483836" while the weight of GGRM worth "−0.19502", whereas the average value of BBNI's shares is smaller than that of GGRM's, namely "-0.000275258" for BBNI and "0.004136322" for GGRM. This is influenced because the investor's view value of BBNI's shares is optimistic, while GGRM's shares are optimist and pessimist.

Another study conducted by Juni Meli Indrasari, Tumpal P Nababan, Bustami in paper [7]. This study uses stock data from BBNI.JK, BBTN.JK, and INDF.JK in the period 02 September 2014 to 30 November 2014. INDF.JK shares have the lowest weight value compared to other stock weights, namely "-0.45600", this is occurs because the average value of the stock is only "-0.00070" and in the investor view matrix, the stock has a pessimist value.

From research conducted related to portfolio optimization using the Black-Litterman model, the value of the investor view will be very influential in determining the weight of each stock, when the stock return value is high but has a pessimistic investor view value, the stock may get a low weight.

IV. CONCLUSION

This study focuses on identifying and creating an optimal portfolio for active investors using the *Black*-Litterman model. The stocks used in this study are stocks contained in the LQ45 index, namely BBCA.JK and TLKM.JK, stock data starts collectively from July 3, 2018 to June 27, 2022 with an interval of 1 week and only takes the value of Adj Close. The Black-Litterman model adds an additional variable, namely the view of investors in portfolio formation. Investor views in this research are based on the use of the MA (Moving Average) line on the two stocks, using MA20 and MA50, MA10, and MA100. the results of the tests carried out, the value of each variable will be different every week, because stock movements change very quickly. The value of the investor view matrix also has an impact in calculating the expected return value using the Black-Litterman model. in the third test scenario the value of BBCA.JK's stock return is smaller than the value of BBCA.JK's stock return in the second test scenario, but when the investor's view is 0.1 (optimistic) the number of BBCA.JK's shares is increasing.

In further research, it is hoped that in entering investors' views, it is not only using a crisp MA (Moving Average) in determining investor views, can use analyst recommendations or use machine learning.

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