

# Comparison of CAPM Portfolio Optimization and Black Litterman Model on LQ45 Index Companies

Wiwit Hariyanto<sup>1</sup>, Ruci Arizanda Rahayu<sup>2</sup>, Fityan Izzah Noor Abidin<sup>3</sup>, Nur Fadlilah<sup>4</sup>

<sup>1,2,3,4</sup> Accounting Study Program, Faculty of Business, Law, and Social Sciences, University of Muhammadiyah Sidoarjo  
wiwit.hariyanto@umsida.ac.id

## ABSTRACT

**Introduction** – Before making investment decisions, investors need proper analysis in making investment decisions. In order to reduce investment risk, investors can form a diversified portfolio of their investments. The formation of a stock portfolio can be determined using the Capital Asset Pricing Model (CAPM).

**Purpose** – This study aims to determine the difference in the expected return portfolio value between the CAPM model and the Black Litterman model as a determinant of investment decision making. This research uses a quantitative research approach.

**Methodology/Approach** – The population and sample are 35 stocks that are consistently included in the LQ-45 Index for the 2017-2018 period. To determine whether or not there is a difference between the expected return value of the CAPM model stock portfolio and the expected return value of the Black Litterman model stock portfolio, the testing of the hypothesis using the Independent T-Test test. Where the calculation of the hypothesis uses the help of the PASW Statistic 18 program.

**Finding** – Based on the calculation of the data, the results of this study are obtained that there are 18 stocks included in the CAPM portfolio and 12 stocks included in the Black Litterman portfolio. Based on the hypothesis test using the Paired Sample T-test, it shows that there is a difference in the Expected Return portfolio between the CAPM and Black Litterman methods when the portfolio is optimal.

**Originality/ Value/ Implication** – The object of research uses the LQ45 stock index which is listed on the Indonesia Stock Exchange. The LQ45 index is one of the indexes in Indonesia that is used to rank stocks to become the 45 best and most actively traded stocks

**Keywords:** Expected Return Portofolio, Capital Asset Pricing Model, Black Litterman, Indeks LQ45

## INTRODUCTION

The Indonesian market can be said to be a haven for investors, both local and international. This is because Indonesia is one of the most potential markets in the Asian region. Because Indonesia is still included in the category of developing countries in the world, this also encourages a lot of market capitalization by investors and foreign companies who want to expand their marketing network for their products or services to Indonesia.

The reasons above make investment still an important part of the country's economy, because it supports the country's economy, especially for industrial growth in Indonesia. Therefore, the government provides the best service in order to maintain the sustainability of investors to continue to invest in Indonesia. Investment is an investment transaction between parties who need capital and those who want to invest with the aim of obtaining returns in the future. Generally, investment is divided into two types, namely investment in financial assets and investment in real assets. Investments in financial assets in the money market include certificates of deposit, commercial paper, money market securities, and others.

The capital market in a narrow sense is a stock exchange, which is a place or means of trading securities among investors. Transactions in the capital market only exist when a company changes its status from a previously closed

company to a public company or commonly referred to as an Initial Public Offering (IPO). Usually the securities traded have a lifespan of more than one year, for example stocks, bonds, mutual funds, warrants and so on. Through the capital market, people have a place to find and look for land with the aim of investing or investing. In addition, the capital market is also a source of capital or a source of financing for the community in the business world because one of the functions of the capital market is as a means of transferring funds from lenders to borrowers. Of the many instruments traded in the capital market, stocks are one of the instruments from the capital market that are most in demand by the public, because stocks provide the expected rate of return. Shares can be interpreted as securities that are used as proof of ownership or participation in a company.

Before making investment decisions, investors need proper analysis in making investment decisions. As for the stages in making investment decisions, among others, investors must determine investment objectives, selection of investment policies, selection of portfolio strategies, selection of assets, selection and evaluation of portfolio performance. So that later you can analyze and choose stocks that are considered safe and able to generate the expected return.

In investing, investors cannot get certainty about the results obtained. While the purpose of the investment itself is to get the maximum return, while in reality return and risk are two

things that are closely related and cannot be separated from each other. On the other hand, investors cannot judge how much risk they will bear. The relationship between risk and expected return is positive, so if the expected rate of return is high, the level of risk that is likely to be borne by investors is also high, and vice versa if you expect a low level of risk, the rate of return that will be obtained is also low. Return is the return / profit for the sacrifices that have been made. Meanwhile, risk is the loss of uncertainty that will be faced by investors.

In order to reduce investment risk, investors can form a diversified portfolio of their investments or in other words divide investment risk into various different stock sectors. The risk that can be diversified is the risk that is not systematic for the company. Diversification is a strategy undertaken by investors to invest not only in one stock sector, but also in several stock sectors. With the aim that if one stock sector suffers a loss, the other stock sector experiences a profit.

The optimal portfolio is formed from an efficient portfolio according to Levy (2010) the efficient portfolio is a combination of investments that provide the same return value with minimal risk or with the same level of risk providing maximum return. Therefore, the formation of a portfolio can minimize risk with a certain level of return.

The formation of a stock portfolio can be determined using the Capital Asset Pricing Model (CAPM). This model was introduced by Sharpe, Lintner, and Mossin twelve years after Harry Markowitz put forward the modern portfolio theory in 1952. Through this model, investors can find out how the level of return and risk that will be received from each stock that forms a portfolio so that it can be used as a decision maker. Because the risk measure used is stock beta. CAPM is a method that incorporates the element of stock risk into the minimum return. The higher the risk of a stock, the higher the minimum expected return (Levy, 2010).

Meanwhile, one method to determine the optimal portfolio is by using the Black Litterman model. This model is a development of the CAPM which was developed in 1990 at Goldman Sachs by Black and Litterman, where the formulation of determining the weights in the portfolio is not solely seen from historical data alone. Urom, Chevallier, and Zhu (2020) states that Black Litterman is a model that uses equilibrium return data combined with opinions from investors to form a new opinion. With this model, it can be used to optimize investor profits by providing different proportions of capital for each portfolio stock. The two models applied will encourage investors to choose and use it as an investment decision-making material which of course has a high return value with minimal risk.

In this study, the object of research uses the LQ45 stock index which is listed on the Indonesia Stock Exchange. The LQ45 index is one of the indexes in Indonesia that is used to rank stocks to become the 45 best and most actively traded

stocks which are updated every 6 months in early February and August. The LQ45 index is a collection of stocks from various sectors that have a high level of liquidity, and a large market capitalization value. Meanwhile, LQ45 shares are shares that have passed the selection according to several assessment criteria so that they are worthy of being traded because they have good growth prospects and have low risk.

## LITERATURE REVIEW

### *Capital Asset Pricing Model (CAPM)*

The Capital Asset Pricing Model (CAPM) was developed by William Sharpe, John Lintner and Jan Mossin (between 1964-1966), exactly twelve years after Harry Markowitz proposed the modern portfolio theory of Markowitz's mean-variance model in 1952. The CAPM model is a balance model which describes the relationship between risk and return in a simpler way, and uses only one variable (referred to as beta) to describe risk (Johnstone, 2020).

### *Model Black Litterman*

The Black Litterman model was introduced by Fischer Black and Robert Litterman at Goldman Sachs in 1990. The use of the Black Litterman Model is a mathematical model for allocating portfolios and is a solution to the problem of optimizing returns, namely through determining the weighting (proportion) of each constituent stock (da Fonseca, 2020). This model is used to determine the optimal portfolio. This model combines two types of information, namely the return equilibrium from the CAPM and the expected return views of investors which are the reference points of this Black Litterman model.

## METHOD

This study uses a quantitative approach and the data source or research object is secondary data.

### *a. Metode Capital Asset Pricing Model (CAPM)*

Is a model of the relationship between risk and expected return of a portfolio or security.

CAPM calculation formula, namely:

$$E(R_i) = r_f + \beta_i [E(R_M) - r_f]$$

Where :

$E(R_i)$  = expected return of stock i

$r_f$  = risk-free security returns

$E(R_M)$  = market portfolio expected return

$\beta_i$  = beta of a security to market portfolio risk

Source: (Zhang 2017)

### *a. Stock returns*

$$R_{(i,t)} = (P_t - P_{(t-1)}) / P_{(t-1)}$$

= (Current Period Prices - Past Period Prices) / (Past Period Prices)

### b. Systematic Risk ( $\beta_i$ )

Beta is a measure of the volatility of a security's return or portfolio return on market returns. The beta of the i-th security measures the return volatility of the i-th security with market returns. The formula for calculating the systematic risk of each individual stock ( $\beta$ ) using the Capital Asset Pricing Model is:

$$R_i = RBR + \beta_i \cdot (RM - RBR) + e_i$$

Where:

$R_i$  = return of the i-th security

RBR = risk-free asset return

RM = market portfolio return

$\beta_i$  = Beta of the i-th security

Sources : (Alqisie and Alqurran 2021)

### c. Black Litterman Model

Black Litterman identifies two sources of information about expected return (consisting of return equilibrium from CAPM and investment manager views) and combines these two information into a new expected return formula that will be used for portfolio optimization process. Black Litterman's expected return formula:

$$\mu_{BL} = \pi + (\tau \Sigma P' (\Omega + P \tau \Sigma P')^{-1}) (V - P \pi)$$

Where :

$\mu_{BL}$  = expected return model Black Litterman

$\pi$  = vector k x 1 for CAPM equilibrium return

$\Sigma$  = variance matrix of return covariance

$\Omega$  = covariance diagonal matrix of views

P = Matrix k x n for views related to return

V = Vector k x 1 for views of return given by investors

Sources : (Bai et al., 2019)

### d. Return Equilibrium

This Equilibrium Return comes from the CAPM Return Equilibrium. There are several assumptions that underlie the CAPM so that the market is said to be in equilibrium. Among them are assuming all investors use mean variance analysis in their portfolio selection, secondly, all investors have the same confidence in returns, and the last assumption is that there is a certain risk-free interest rate that can be used by all investors.

To determine whether or not there is a difference between the expected return value of the CAPM model stock portfolio and the expected return value of the Black Litterman model stock portfolio. Then testing the hypothesis using the Independent T-Test test (Sugiyono,

2015). Where the calculation of the hypothesis uses the help of the PASW Statistics 18 program.

## RESULT AND DISCUSSION

### a. Normality test

The assumption of normality in a group of data refers to the shape of the distribution of the data, whether it is in the form of a normal distribution or not. In this study, the normal distribution was detected using the Kolmogorov-Smirnov (K-S) non-parametric statistical test.

**Table 1. Results of the Normality Test for Expected Return CAPM and Black Litterman**

One-Sample Kolmogorov-Smirnov Test			
		CAPM	BL
N		18	18
Normal	Mean	0,0002815	0,00309278
Parameters <sup>a,b</sup>	Std. Deviation	0,000239137	0,006694909
Most Extreme Differences	Absolute	0,129	0,271
	Positive	0,129	0,271
	Negative	-0,123	-0,139
Kolmogorov-Smirnov Z		0,548	1,15
Asymp. Sig. (2-tailed)		0,925	0,142
a. Test distribution is Normal.			
b. Calculated from data.			

Source: Data processed through SPSS 2020

Normal distributed data showed a significance value above 0.05. Based on the table above, Kolmogorov – Smirnov normality test results on 18 samples of companies listed in the LQ-45 Index show that the CAPM and Black Litterman portfolio expected return variables have a significance value of 0.925 each; 0.142 which means that the variable is normally distributed.

### b. Different Test Results

The difference test in the table below is used to see the difference in the expected return portfolio value between the CAPM Model and the Black Litterman Model.

**Table 2. Results of the Different Expected Return Portfolio Test between CAPM and Black Litterman**

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tail ed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Has sil	Equal varianc es assumed	96,043	,000	3,099	26	,005	-.00143	,00046	-.00237	-.00048
	Equal varianc es not assumed			2,297	9,150	,047	-.00143	,00062	-.00283	-.00002

Source: Data processed through SPSS 2020

Based on the table above, it can be seen that the F value of Levene's test for equality of variance is 96.043 with a

probability of 0.000 because the probability is  $<0.05$ , it can be concluded that the expected return of the CAPM and Black Litterman portfolios has unequal variance. Thus, the t-test difference test must use the equal variance assumed assumption. From the SPSS output, it can be seen that the t value in the equivalent variance assumed is -3.099 with a significance probability value of 0.005 (less than 0.05). It can be concluded that there is a difference in the expected return portfolio value between CAPM and Black Litterman.

## 2. Discussion of Research Results

### a) Efficient Stock Formation Analysis

The initial step is to determine the expected return to choose which stocks are included as efficient and inefficient stocks and are included in the candidate for the formation of an optimal portfolio using the capital asset pricing model approach. If the stock return is smaller than the expected return, it is categorized as an inefficient stock. However, if the stock return is greater than the expected return, it is categorized as an efficient stock. The results of the calculation of 35 shares of LQ-45 there are 18 companies that have a value of  $R_i > E(R_i)$ .

### b) Optimal Portfolio Formation Analysis

Determination of the optimal portfolio formation is done by arranging the excess return to beta (ERB) ranking from the highest value to the lowest value. Determination of this ERB requires an analysis of the expected return, beta and risk free rate. While the determination of the cut-off rate ( $C_i$ ) is done by analyzing the results of the calculation of expected return, residual error variance, and risk free rate.

The criteria in determining the optimal portfolio is ERB  $C_i$ , from the calculation results by comparing ERB and  $C_i$ , there are 18 stocks that are included as the optimal portfolio. The  $C_i$  calculation is used to determine the cut off point ( $C^*$ ) which is carried out by observing the maximum  $C_i$  value from a series of  $C_i$  values. The value of  $C^*$  is used to determine which stock limit points are included as optimal portfolio candidates. The calculation results show the value of  $C^*$  on shares of 0.00083518 which is in Aneka Tambang Tbk's shares.

### c) Optimal Portfolio Fund Proportion Analysis

Determining the weighted scale needs to be done first to determine the proportion of funds that investors will invest. This weighted scale analysis uses the results of beta calculations, residual error variance, excess return to beta, and the determination of the cut-off point.

### d) Analysis of Expected Return Portfolio CAPM Model and Black Litterman Model

As a consideration for investors, then from the results of the proportion of funds for each stock that has been calculated previously, it can be obtained the expected

return of the portfolio that is borne by the investor when making an investment.

In this study, the level of expected return for the CAPM method portfolio (which consists of 18 stocks) is 0.00507. While the level of Expected Return Portfolio Black Litterman method (which consists of 10 stocks) is 0.01707. It is expected that the level of expected return on the portfolio received can add more information about the performance or portfolio analysis produced in this study.

The results of this study reflect the title of this study. Comparison of CAPM Portfolio Optimization and Black Litterman Model as Determinants of Investment Decision Making. CAPM is a portfolio calculation model that links risky assets with market indexes and risk-free assets. The CAPM summarizes all relevant economic factors with a single macroeconomic indicator and assumes that these move the securities market as a whole. According to the CAPM concept, the only factor that affects return is market risk. While the Black Litterman Model is a combination of the equilibrium return achieved through the CAPM with the Investor's View. Because investors must be precise in determining strategies and investment decisions to get optimal profits.

### e) Hypothesis Test Results

From the results of hypothesis testing that has been carried out, it can be concluded that the hypothesis ( $H_1$ ) is the expected return portfolio value which is proven to be a difference between the CAPM method and the Black Litterman. The difference in the value of the expected return of the portfolio between the CAPM Model and the Black Litterman when the portfolio is optimal.

Hypothesis 1 ( $H_1$ ) states that there is a difference in the expected return of the CAPM and Black Litterman methods when the optimal portfolio is formed. From the SPSS output, it can be seen that the t value in the equivalent variance assumed is -3.099 with a significance probability value of 0.005 (Probability  $<0.05$  then  $H_1$  is accepted). It can be concluded that there is a difference in the expected return value of CAPM with Black Litterman.

This is because in the Black Litterman model there is an addition by including the intuition or views of investors in investing, so this results in the emergence of differences in the expected return portfolio value between the CAPM model and the Black Litterman which is not much different.

The results of these studies support research (Ratri 2015) which states that the optimal portfolio calculation using the Black Litterman model is able to provide the best model. This model can be used as a reference in obtaining better profits for investors.

## CONCLUSION AND RECOMMENDATION

### a. Conclusion

Based on the analysis of research results with calculations using the CAPM and Black Litterman models on LQ-45 shares listed on the Indonesia Stock Exchange for the 2017-2018 period and an analysis supported by the underlying theories, as well as the results of the discussion in previous chapters, it follows that at the end of the research conclusions can be drawn:

1. There are 18 stocks that meet the criteria for forming an optimal stock portfolio using the CAPM model and 10 using the Black Litterman model. Stocks that meet the criteria for forming an optimal stock portfolio using the CAPM model include EXCL (XL Axiata Tbk.), INCO (Vale Indonesia Tbk.), ICBP (Indofood Cbp Sukses Makmur Tbk.), UNTR (United Tractors Tbk.), BMRI (Bank Mandiri Persero Tbk.), KLBF (Kalbe Farma Tbk.), BBTN (State Savings Bank Persero Tbk.), HMSP (HM Sampoerna Tbk.), JSMR (Jasa Marga Persero Tbk.), SMGR (Semen Indonesia Persero Tbk.), SRIL (Sri Rejeki Isman Tbk.), INTP (Indocement Tunggul Prakarsa Tbk.), BBKA (Bank Central Asia Tbk.), GGRM (Gudang Garam Tbk.), BBNI (Bank Negara Indonesia Persero Tbk.), ASII (Astra International Tbk.), UNVR (Unilever Indonesia Tbk.), ANTM (Aneka Tambang Tbk.).
2. There are 10 stocks that meet the criteria for forming an optimal stock portfolio with the Black Litterman model, including ICBP (Indofood Cbp Sukses Makmur Tbk.), UNTR (United Tractors Tbk.), HMSP (HM Sampoerna Tbk.), JSMR (Jasa Marga Persero Tbk.), SMGR (Semen Indonesia Persero Tbk.), SRIL (Sri Rejeki Isman Tbk.), BBKA (Bank Central Asia Tbk.), BBNI (Bank Negara Indonesia Persero Tbk.), UNVR (Unilever Indonesia Tbk.), ANTM (Aneka Tambang Tbk.).
3. The proportion of funds that are eligible to be invested in 18 stocks of the CAPM model is:
  - a) 0,00450 (0,45%) allocated to EXCL shares (XL Axiata Tbk.),
  - b) 0,01045 (1,05%) allocated to INCO shares (Vale Indonesia Tbk.),
  - c) 0,09773 (9,77%) allocated to ICBP shares (Indofood Cbp Sukses Makmur Tbk.),
  - d) 0,02628 (2,63%) allocated to shares of UNTR (United Tractors Tbk.),
  - e) 0,15766 (15,77%) allocated to shares of BMRI (Bank Mandiri Persero Tbk.),
  - f) 0,10234 (10,23%) allocated to KLBF shares (Kalbe Farma Tbk.),
  - g) 0,02944 (2,94%) allocated for shares of BBTN (State Savings Bank Persero Tbk.),
  - h) 0,15094 (15,09%) allocated to HMSP shares (H.M Sampoerna Tbk.),
  - i) 0,02939 (2,93%) allocated to JSMR shares (allocated to JSMR shares.),
  - j) 0,02867 (2,87%) allocated to SMGR saham shares (Semen Indonesia Persero Tbk.),
  - k) 0,00251 (0,25%) allocated to SRIL shares (Sri Rejeki Isman Tbk.),
  - l) 0,03579 (3,58%) allocated to INTP shares (Indocement Tunggul Prakarsa Tbk.),
  - m) 0,07350 (7,35%) allocated to BBKA shares (Bank Central Asia Tbk.),
  - n) 0,05838 (5,84%) allocated to GGRM shares (Gudang Garam Tbk.),
  - o) 0,07333 (7,33%) allocated to BBNI shares (Bank Negara Indonesia Persero Tbk.),
  - p) 0,06338 (6,34%) allocated to ASII shares (Astra International Tbk.),
  - q) 0,05484 (5,48%) allocated to UNVR shares (Unilever Indonesia Tbk.),
  - r) 0,00098 (0,10%) allocated to ANTM shares (Aneka Tambang Tbk.).
4. The proportion of funds that are worth investing in 10 Black Litterman model stocks is:
  - a) 0,29554 (30%) allocated to ICBP shares (Indofood Cbp Sukses Makmur Tbk.),
  - b) 0,03811 (4%) allocated to UNTR shares (United Tractors Tbk.),
  - c) 0,05764 (6%) allocated to HMSP shares (H.M Sampoerna Tbk.),
  - d) 0,06921 (7%) allocated to JSMR shares (Jasa Marga Persero Tbk.),
  - e) 0,04929 (5%) allocated to SMGR shares (Semen Indonesia Persero Tbk.),
  - f) 0,03514 (4%) allocated to SRIL shares (Sri Rejeki Isman Tbk.),
  - g) 0,03214 (3%) allocated to BBKA shares (Bank Central Asia Tbk.),
  - h) 0,16939 (17%) allocated to BBNI shares (Bank Negara Indonesia Persero Tbk.),
  - i) 0,15781 (16%) allocated to UNVR shares (Unilever Indonesia Tbk.),
  - j) 0,09572 (10%) allocated to ANTM shares (Aneka Tambang Tbk.).
5. There is a difference in the value of the expected return of the portfolio between the CAPM model and the Black Litterman.
  - a. Suggestion
 

Suggestions from this research are:

    - 1) Investors can invest their funds in eighteen stocks for the CAPM model or ten stocks for the Black Litterman model as an alternative choice to get high returns.
    - 2) In investing, investors need to take stock price movements into account through technical analysis and see the performance of issuers through fundamental analysis. The best analytical method that investors can use in analyzing their

investment assets is to analyze data related to the issuer.

- 3) For further research can add conditions in sample collection by entering the criteria "the company does not occur auto reject at all" and extend the observation period, so that the results obtained can reflect the condition of the company in general.
- 4) For future researchers, it is better to find out how the Black Litterman Model is formed. including the Sampling Method, Bayes Approach and Theil Mixed Method
- 5) Investors should use Black Litterman's Model portfolio, because this model is a development of other portfolio models that include an investor's intuition or view in investing.

c. Research Limitations

The limitations of this comparative study on the optimization of the CAPM Portfolio and the Black Litterman Model as a Determinant of Investment Decision Making are that it does not describe the security market line, does not explain how the Black Litterman Model is formed because researchers do not have sufficient experience in the investment world and the number of research samples is relatively small a little.

## REFERENCES

- Alqisie, Ahmad, and Talal Alqurran. 2021. "Validity of Capital Assets Pricing Model (CAPM) (Empirical Evidences from Amman Stock Exchange)." *Journal of Management Research*.
- Bai, Hang et al. 2019. "The CAPM Strikes Back? An Equilibrium Model with Disasters." *Journal of Financial Economics*.
- da Fonseca, José Soares. 2020. "Portfolio Selection in Euro Area with CAPM and Lower Partial Moments Models." *Portuguese Economic Journal*.
- Johnstone, David. 2020. "Fama's Ratio and the Effect of Operating Leverage on the Cost of Capital Under CAPM." *Abacus*.
- Levy, Haim. 2010. "The CAPM Is Alive and Well: A Review and Synthesis." *European Financial Management*.
- Ratri, Arum, Virgina Dewi Kusuma. 2015. "Analisis Portofolio Optimum Saham Syariah Dengan Model Black Litterman." *Jurnal Fourier*.
- Sugiyono. 2015. *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D*. Cetakan ke. Bandung: Alfabeta.
- Urom, Christian, Julien Chevallier, and Bangzhu Zhu. 2020. "A Dynamic Conditional Regime-Switching GARCH CAPM for Energy and Financial Markets." *Energy Economics*.
- Zhang, Lu. 2017. "The Investment CAPM." *European Financial Management*.