



Formation of an Optimal Stock Portfolio for the Infobank15 Index Using the Liquidity-Adjusted Capital Asset Pricing Model (LCAPM)

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ARTICLE INFO	ABSTRACT
<p>Published Online: 08 December 2025</p> <p>Corresponding Author: Agus Rusgiyono</p>	<p>Investing involves allocating funds in the present with the expectation of obtaining future returns. One common type of financial investment is stock investment. Diversifying investments across various companies enables investors to reduce the risks associated with individual stock performance. One approach used in constructing a stock portfolio is the Liquidity-Adjusted Capital Asset Pricing Model (LCAPM), a modification of the traditional CAPM that incorporates liquidity risk. The Sharpe Index is employed to evaluate the performance of the constructed portfolio. This study utilizes closing price data, trading volume, and total transaction volume of stocks listed in the Infobank15 Index, along with the Composite Stock Price Index (JCI) and the Bank Indonesia Certificate interest rate, covering the period from January 2020 to December 2023. The results indicate that the optimal portfolio consists of three stocks, with allocation proportions of 12.31% for BRIS, 75.88% for BBKA, and 11.81% for BBNI.</p>
<p>KEYWORDS: Portfolio, Infobank15, LCAPM, The Sharpe Index.</p>	

I. INTRODUCTION

Investment is the act of allocating a certain amount of funds in the present with the expectation of obtaining returns or profits in the future (Halim, 2005). Financial investments such as stocks, bonds, and mutual funds are increasingly preferred over real investments, as evidenced by the growth of investment activity in the capital market according to the Indonesian Stock Exchange in August 2023. According to the Capital Market Law No. 8 of 1995, the capital market is defined as activities related to public offerings and the trading of securities, public companies associated with the securities they issue, as well as institutions and professions related to securities. One type of security traded on the stock exchange is stocks. Stocks are financial instruments that represent ownership in a company. Stock ownership can be obtained through investing. Investing in stocks is generally conducted to achieve the highest possible return with the lowest or minimal level of risk. Diversification is one method that can be employed to minimize risk. Portfolio diversification is defined as the process by which investors form a portfolio by selecting a combination of assets in such a way that risk can be minimized without reducing the expected return (Machfiroh, 2016).

One method for determining an optimal stock portfolio is the Liquidity-Adjusted Capital Asset Pricing Model (LCAPM). This method is an extension of the traditional Capital Asset Pricing Model (CAPM). The LCAPM was developed by Acharya and Pedersen in 2005. The enhancement made in the LCAPM involves incorporating liquidity aspects into its calculation and considering the effect of liquidity risk in portfolio formation. Liquidity risk refers to the risk associated with the ability of a stock to be traded immediately without incurring significant losses (Halim, 2005). Trading Volume Activity (TVA) is one of the measures used to assess stock liquidity.

A previous study by Sofianida (2019), titled “*Analysis of Optimal Stock Portfolio Formation Using the Liquidity-Adjusted Capital Asset Pricing Model*,” used stock data from companies in the consumer goods industry sector for the period of August 2016 to August 2017 and resulted in an investment allocation for five optimal stocks. However, the study did not calculate the portfolio’s expected return, portfolio risk, or evaluate the performance of the resulting stock portfolio. Therefore, the present study includes the calculation of expected return, portfolio risk, and an analysis of the performance of the constructed stock portfolio. The object of this study is the Infobank15 stock index, which

consists of fifteen banking-sector stocks that meet the criteria set by the Indonesia Stock Exchange.

Based on the preceding explanation, this study employs the LCAPM method in forming an optimal stock portfolio using monthly stock data from the Infobank15 Index for the period January 2020 to December 2023. After the portfolio is constructed, its performance will be evaluated using the Sharpe Index. All calculations in this study are carried out with the assistance of Microsoft Excel and RStudio software.

II. LITERATURE REVIEW

Return refers to the gain obtained from an investment (Hartono, 2019). Stock returns are calculated based on stock closing price data. The calculation of stock returns is carried out using Equation (1) as follows:

$$R_{i,t} = \ln \left(\frac{P_{i,t}}{P_{i,(t-1)}} \right) \quad (1)$$

Description:

$R_{i,t}$: Return of stock i at time t

$P_{i,t}$: Closing price of stock i at time t

$P_{i,(t-1)}$: Closing price of stock i at time $(t-1)$

i : Index indicating the stock

Whereas market return is calculated using data from the Composite Stock Price Index (JCI). The market return is computed using Equation (2) as follows:

$$R_{M,t} = \ln \left(\frac{IHSG_t}{IHSG_{t-1}} \right) \quad (2)$$

Description:

$R_{M,t}$: Market return at time t

$IHSG_t$: Jakarta Composite Index (JCI) at time t

$IHSG_{t-1}$: Jakarta Composite Index (JCI) at time $(t-1)$

A portfolio can be defined as a collection or combination of assets—either real assets or financial assets—owned by an investor (Halim, 2005). Stock diversification aims to obtain the most efficient portfolio, namely a portfolio with the lowest possible risk while providing the highest return compared to other portfolio combinations (Zubir, 2012). The expected return of a portfolio is used to estimate the future return of the constructed portfolio. The portfolio's expected return is defined as the weighted average of the expected returns of the individual stocks within the portfolio. Equation (3) below is used to calculate the expected return of the portfolio (Hartono, 2019):

$$E(RP) = w_1E(R_1) + w_2E(R_2) + \dots + w_mE(R_m) = \sum_{i=1}^m w_iE(R_i) \quad (3)$$

Description:

$E(RP)$: Expected return of the portfolio

w_i : Proportion of stock i

$E(R_i)$: Expected return of stock i

m : Number of optimal stocks

i : Index indicating the stock

Whereas portfolio risk is defined as the standard deviation of the returns of the stocks that form the portfolio (Hartono, 2019). Portfolio risk reflects the potential level of risk that may arise from the constructed portfolio. Equation (4) below is used to calculate portfolio risk (Hartono, 2019):

Description:

$$\sigma_P = \sqrt{E(RP - E(RP))^2} \quad (4)$$

σ_P : Standard deviation of the portfolio

RP : Portfolio return

$E(RP)$: Expected portfolio return

Stock liquidity refers to the measure of transaction volume of a stock in the capital market during a certain period (Anggiyanti, 2018). According to the Indonesia Stock Exchange, stock liquidity is defined as the smoothness or ease with which an investment can be converted into cash. The higher the trading frequency of a stock, the higher its liquidity level. Trading Volume Activity (TVA) is one method used to measure stock liquidity. TVA is defined as the volume of trades occurring in the stock exchange at a given time, which also influences stock price movements (Suganda, 2018). TVA can be calculated using Equation (5) as follows:

$$l_{i,t} = \frac{\text{Trading Volume of Stock}_{i,t}}{\text{Total Stock Volume}_{i,t}} \quad (5)$$

Meanwhile, market liquidity refers to the liquidity value obtained from the overall market volume or the total transaction volume of the stocks listed in the Composite Stock Price Index (JCI). Market liquidity can be calculated using Equation (6) as follows:

$$l_{M,t} = \frac{\text{Market Trading Volume at } IHSG_t}{\text{Total Market Shares Volume at } IHSG_t} \quad (6)$$

A risk-free asset is defined as an asset whose future return can be known with certainty (Adnyana, 2020). The Bank Indonesia Certificate (SBI) is considered a risk-free asset issued by Bank Indonesia. Therefore, the return on a risk-free asset refers to the interest rate of the Bank Indonesia Certificate during a given period. Mathematically, the return on a risk-free asset is calculated using Equation (7) as follows (Indriana, 2015):

$$RBR = \frac{\sum_{i=1}^p (r_i / 12)}{p} \quad (7)$$

Description:

RBR : Return of the risk-free asset

r : Bank Indonesia interest rate

p : Number of observation periods

The Liquidity-Adjusted Capital Asset Pricing Model (LCAPM) is an extension of the Capital Asset Pricing Model (CAPM) that incorporates liquidity aspects into the calculation of expected return and considers the influence of

liquidity risk in portfolio formation. LCAPM uses liquidity betas as measures of the systematic risk of individual stocks or portfolios in relation to market liquidity risk. The model includes four liquidity betas in its formulation β_{1i} for

liquidity beta that measures the relationship between the return of stock i and the market return, β_{2i} for liquidity beta

that measures the relationship between the liquidity of stock i and market liquidity, β_{3i} for liquidity beta that measures the

relationship between the return of stock i and market liquidity, β_{4i} for liquidity beta that measures the relationship

between the liquidity of stock i and the market return.

In general, the LCAPM equation is expressed in Equation (8) below (Acharya & Pedersen, 2005):

$$E(R_i) = R_{BR} + E(l_i) + \lambda_i(\beta_{1i} + \beta_{2i} - \beta_{3i} - \beta_{4i}) \quad (8)$$

$$\beta_{1i} = \frac{\text{cov}(R_i, R_M)}{\text{var}(R_M - l_M)} \quad (9)$$

$$\beta_{2i} = \frac{\text{cov}(l_i, l_M)}{\text{var}(R_M - l_M)} \quad (10)$$

$$\beta_{3i} = \frac{\text{cov}(R_i, l_M)}{\text{var}(R_M - l_M)} \quad (11)$$

$$\beta_{4i} = \frac{\text{cov}(l_i, R_M)}{\text{var}(R_M - l_M)} \quad (12)$$

$$E(l_i) = \frac{\sum_{t=1}^n l_{i,t}}{n} \quad (13)$$

$$\lambda = E(R_M - l_M - RBR) \quad (14)$$

Description:

$E(R_i)$: Expected return of stock i

RBR : Risk-free asset return

$E(l_i)$: Expected liquidity of stock i

λ : Liquidity lambda

R_M : Market return

l_M : Market liquidity

The expected return of each stock is influenced by the expected liquidity of that stock. The higher the expected liquidity of a stock, the higher its expected return. In the LCAPM, liquidity lambda is used to measure the market liquidity premium in a stock portfolio. A high liquidity lambda indicates a strong market influence on the stock portfolio (Acharya & Pedersen, 2005).

An optimal portfolio can be determined by using a measure that selects which stocks should be included in the optimal stock portfolio. This measure is the ratio between excess return and beta. Excess return is the difference between the expected return and the risk-free asset return. The Excess Return to Beta (ERB) measures the excess return relative to one unit of non-diversifiable risk, which is represented by

beta (Hartono, 2019). The ERB can be calculated using Equation (15) as follows:

$$ERB_i = \frac{E(R_i) - RBR}{\beta_i} \quad (15)$$

$$\beta_i = \beta_{1i} + \beta_{2i} - \beta_{3i} - \beta_{4i} \quad (16)$$

Description:

ERB_i : Excess Return to Beta of stock i

$E(R_i)$: Expected return of stock i

RBR : Risk-free asset return

β_i : Beta of stock i

i : Index indicating the stock

An optimal portfolio will consist of assets with high ERB values. Therefore, a cut-off point is needed to determine the threshold for ERB values considered high. The magnitude of the cut-off point can be determined through the following steps:

1. Stocks are ranked from the highest to the lowest ERB value. The best stocks to include in the optimal portfolio are those with the highest ERB values.

2. The values of A_i and B_i are calculated for each stock i to determine the Cut-off Rate using Equations (17) and (18) as follows:

$$A_i = \frac{(E(R_i) - RBR) \cdot \beta_i}{\sigma_{ei}^2} \quad (17)$$

$$B_i = \frac{\beta_i^2}{\sigma_{ei}^2} \quad (18)$$

$$\sigma_M^2 = \frac{\sum_{i=1}^n (R_M - E(R_M))^2}{n-1} \quad (19)$$

$$\sigma_i^2 = \frac{\sum_{i=1}^n (R_i - E(R_i))^2}{n-1} \quad (20)$$

$$\sigma_{ei}^2 = \sigma_i^2 - \beta_i^2 \cdot \sigma_M^2 \quad (21)$$

Description:

σ_M^2 : Variance of market return

σ_i^2 : Variance of stock i return

$E(R_i)$: Expected return of stock i

RBR : Risk-free asset return

β_i : Beta of stock i

σ_{ei}^2 : Residual variance of stock i

3. The Cut-off Rate (C_i) is calculated by comparing it with the ERB value of each stock using Equation (22) as follows:

$$C_i = \frac{\sigma_M^2 \sum_{j=1}^i A_j}{1 + \sigma_M^2 \sum_{j=1}^i B_j} \quad (22)$$

4. Cut-Off Point (C^*) Value

After calculating the C_i (Cut-off Rate for each stock), the next step is determining the Cut-Off Point (C^*). Rank the stocks based on their ERB (Excess Return to Beta) from the highest to the lowest. Compute C_i for each stock according to that order. The Cut-Off Point (C^*) is the last C_i value for which the following condition still holds, $ERB \geq C_i$. In other words, C^* is the C_i at the point where a stock's ERB is still greater than or equal to its C_i . The stock at this position determines the Cut-Off Point (C^*).

The amount of funds to be invested or allocated to each selected stock is determined by the proportion of each stock. Equations (23) and (24) below are used to calculate the stock proportions (Hartono, 2019).

$$w_i = \frac{z_i}{\sum_{j=1}^m z_j} \quad (23)$$

$$z_i = \frac{\beta_i}{\sigma_{ei}^2} (ERB_i - C^*) \quad (24)$$

Description:

w_i : Proportion of the portfolio for stock i

β_i : Beta of stock i

σ_{ei}^2 : Residual variance of stock i

ERB_i : Excess Return to Beta of stock i

C^* : Cut-off Point

m : Number of optimal stocks

i : Index representing the stock

One of the portfolio performance measures based on the portfolio’s net return relative to the risk-free interest rate is the Sharpe Index. A portfolio will perform better when it has a higher Sharpe Index value. Equation (25) below is used to calculate the Sharpe Index (Halim, 2005):

$$S_p = \frac{E(RP) - RBR}{\sigma_p} \quad (25)$$

Description:

S_p : Sharpe Index

$E(RP)$: Expected portfolio return

RBR : Portfolio standard deviation

σ_p : Portfolio standard deviation

III. RESEARCH METHOD

This study employs secondary data consisting of monthly closing prices of the constituent stocks of the Infobank15 Index and the IHSG for the period January 2020–December 2023, obtained from www.finance.yahoo.com. Additional data used include monthly transaction volumes and total trading volumes of the Infobank15 and IHSG constituent stocks, sourced from www.idx.co.id. Meanwhile, the risk-free rate data are derived from the monthly Bank Indonesia interest rate (BI Rate), obtained from www.bi.go.id.

1. Monthly data are collected for stock closing prices, transaction volumes, total market volumes of Infobank15 and IHSG, and the risk-free rate (January 2020 – December 2023).

2. Stock returns and market returns are computed from closing prices, while stock and market liquidity are calculated using transaction volume and total traded volume of Infobank15 and IHSG.

3. Expected stock liquidity and expected market liquidity are measured using average liquidity values. Liquidity lambda is calculated from market returns, market liquidity, and the risk-free rate.

4. Four liquidity betas for each Infobank15 stock are estimated, followed by calculating expected stock returns using the Liquidity-Adjusted CAPM (LCAPM).

5. Excess return-to-beta (ERB) is computed for each stock and ranked. The cut-off rate (C_i) is calculated, and the optimal cut-off point (C^*) is determined using the last C_i greater than ERB.

6. Stocks with $C_i \geq C^*$ are included in the optimal portfolio. Portfolio weights are derived, followed by the calculation of portfolio expected return, risk, and Sharpe Index.

IV. RESULT

The data used in this study consists of monthly stock data listed in the Infobank15 Index for the period January 2020 – December 2023. There are 15 banking sector stocks included in the Infobank15 Index that have met the assessment criteria set by the Indonesia Stock Exchange (BEI). In addition, several supporting data are also used, including the IHSG (Jakarta Composite Index), Bank Indonesia interest rates, trading volume and total trading volume of Infobank15 stocks, as well as trading volume and total trading volume of IHSG.

A. Beta Liquidity

Liquidity betas are required in forming an optimal stock portfolio using the LCAPM method to determine the systematic risk level. The liquidity beta values are calculated using equations (9), (10), (11), and (12). The results of the liquidity beta calculations for each stock are presented in Table 1

Table 1. Liquidity Beta of Infobank15 Stocks

Stocks	β_1	β_2	β_3	β_4
AGRO	3,226734	0,002829	0,000472	0,613413
ARTO	4,375519	0,000391	0,005633	0,070556
BBCA	0,883568	-0,000354	0,001295	-0,211057
BBHI	3,279242	0,000898	0,005194	0,077467
BBNI	2,312505	-0,000335	0,002225	-0,004977
BBRI	1,473834	-0,000079	0,001311	-0,016906
BBTN	2,911896	-0,000390	0,001719	0,370405
BDMN	1,993329	0,000175	0,001031	0,011778
BJBR	1,510870	0,000565	0,001249	0,168044
BMRI	1,639713	-0,000053	0,001891	-0,067529
BNGA	1,259969	0,000133	0,000698	0,015373
BRIS	2,312664	0,000325	-0,001149	0,966770
BTPS	2,422827	-0,000933	0,001377	0,062449
MEGA	0,216562	0,000002	-0,000418	0,000308
PNBN	1,755960	0,000191	0,003052	0,006212

Based on Table 1, the highest β_1 value is found in ARTO, with a value of 4,375519, which means that if the market return increases by one unit, the return of ARTO will increase by 4,375519. The highest β_2 value is observed in AGRO, with a value of 0,002829, indicating that if market liquidity increases by one unit, the liquidity of AGRO will increase by 0,002829.

The highest β_3 value is recorded for ARTO, with a value of 0,005633, meaning that if market liquidity increases by one unit, the return of ARTO will increase by 0,005633. Finally, the highest β_4 value is found in BRIS, with a value of 0,966770, which implies that if market return increases by one unit, the liquidity of BRIS will increase by 0,966770.

B. Expected Return

The expected return of a stock is used to determine the future return that an investment may generate. The expected return of each stock is influenced by its expected liquidity value. The expected return calculated using the LCAPM method can be obtained through Equation (8). The results of the expected return calculations for each stock are presented in Table 2.

Table 1. Expected Return Infobank15 Stocks

Stocks	$E(l_i)$	$E(R_i)$
AGRO	0,068554	0,072810
ARTO	0,027872	0,032517
BBCA	0,042444	0,046349
BBHI	0,013653	0,018044
BBNI	0,080692	0,084879
BBRI	0,024396	0,028393
BBTN	0,075550	0,079788
BDMN	0,007308	0,011418
BJBR	0,021290	0,025253
BMRI	0,043235	0,047282
BNGA	0,006572	0,010286
BRIS	0,098893	0,102857
BTPS	0,028065	0,032262
MEGA	0,000082	0,003785
PNBN	0,007128	0,011184

Based on Table 2, the highest expected return is obtained by PT Bank Syariah Indonesia Tbk (BRIS) with a value of 0.102857, which indicates that an investment in BRIS yields a return of approximately 10%. In contrast, the lowest expected return is recorded by PT Bank Mega Tbk (MEGA) with a value of 0.003785, meaning that an investment in MEGA provides a return of about 0.38%.

C. ERB (Excess Return to Beta)

The ERB values for each stock that have been calculated are then sorted from the highest to the lowest. The next step is to compute the cut-off rate (C_i) to determine the cut-off point (C^*), based on the ordered ERB values, which serves as the threshold for selecting stocks to be included in the optimal portfolio. The ERB and cut-off rate (C_i) calculations are performed using Equations (15) and (22). The results of the ERB and C_i calculations are presented in Table 3

Table 2. ERB and Cut off Rate Infobank15 Stocks

Stocks	ERB	C_i
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BRIS	0,073627	0,006491
BBCA	0,039063	0,029499
BBNI	0,035087	0,031306
BBTN	0,029982	0,031127
AGRO	0,026439	0,030966
BMRI	0,025582	0,029846
BBRI	0,016611	0,028019
BJBR	0,016093	0,027058
BTPS	0,012132	0,025471
ARTO	0,006713	0,024697
BNGA	0,005513	0,023444
BBHI	0,004500	0,023093
PNBN	0,004311	0,022488
BDMN	0,003920	0,020836
MEGA	0,000608	0,020823

Based on Table 3, the cut-off point (C^*) is 0.031306 for the stock BBNI, which represents the last cut-off rate (C_i) that is still greater than or equal to the corresponding ERB value.

D. Selection of Optimal Stocks

The stocks included in the optimal portfolio are those with ERB values greater than or equal to the cut-off point (C^*), which is 0.031306.

Table 4. Optimal Stock Portfolio

Stocks	$E(l_i)$	$E(R_i)$	ERB	C_i
BRIS	0,098893	0,102857	0,073627	0,006491
BBCA	0,042444	0,046349	0,039063	0,029499
BBNI	0,080692	0,084879	0,035087	0,031306

Based on Table 4, the stocks included in the formation of the optimal portfolio have been identified. These selected stocks are those with high expected liquidity and high expected returns.

E. Stocks Proportions

The optimal portfolio proportions are used to determine the allocation of funds to be invested in each stock. The stock proportions are calculated using Equations (24) and (25). The results of these calculations are presented in Table 5.

Table 5. Stock Proportions

Stocks	(Z_i)	Stocks Proportion (w_i)	Percentage
BRIS	1,574319	0,1230604	12,31%
BBCA	9,706989	0,7587688	75,88%
BBNI	1,511756	0,1181708	11,81%

Based on Table 5, the largest portfolio proportion is allocated to Bank Central Asia Tbk (BBCA) at 75.88%. Meanwhile, the smallest proportion is allocated to Bank Negara Indonesia Tbk (BBNI) at 11.81%. If an investor allocates Rp100,000,000 for investment, then Rp12,310,000 would be invested in BRIS, Rp75,880,000 in BBCA, and Rp11,810,000 in BBNI.

F. Expected Return Portfolio

The expected return of the portfolio is used to estimate the future return of the constructed optimal portfolio. The expected return of the optimal portfolio is calculated using Equation (3), based on the values of w_i and $E(R_i)$

$$E(RP) = \sum_{i=1}^m w_i E(R_i)$$

$$E(RP) = 0,012658 + 0,035168 + 0,010030$$

$$E(RP) = 0,05786$$

The resulting expected return of the optimal portfolio is 0.05786, or 5.8%. This indicates that an investor would obtain a return of approximately 5.8% when investing in the constructed optimal stock portfolio.

The portfolio risk is used to determine the level of risk associated with the constructed optimal portfolio. The portfolio risk is calculated using Equation (4).

$$\sigma_p = \sqrt{E(RP - E(RP))^2}$$

$$\sigma_p = \sqrt{0,001615}$$

$$\sigma_p = 0,04018$$

Based on the calculation, the risk of the optimal portfolio is 0.04018, or 4%. This indicates that an investor faces a potential loss of approximately 4% when investing in the constructed optimal stock portfolio.

G. Sharpe Index

The evaluation of portfolio performance aims to assess whether the investment yields favourable results. The performance of the stock portfolio can be measured using the Sharpe Index, calculated using Equation (25).

$$S_p = \frac{E(RP) - RBR}{\sigma_p}$$

$$S_p = \frac{0,05786 - 0,03654}{0,04018}$$

$$S_p = 1,348761$$

Based on the calculations above, the Sharpe Index yields a positive value, indicating that the expected return of the optimal portfolio is higher than the risk-free return. Therefore, the constructed optimal portfolio generates a profit and demonstrates good performance.

V. CONCLUSION

Based on the results of the previous discussion, it can be concluded that

1. The formation of the optimal portfolio of Infobank15 stocks using LCAPM results in a portfolio consisting of three stocks: BRIS with a proportion of 12.31%, BBKA with 75.88%, and BBNI with 11.81%. The resulting stock portfolio exhibits high expected return and expected liquidity, allowing it to generate optimal returns while remaining easily liquidated.
2. The expected return of the optimal portfolio is 5.8%, indicating that investors may obtain an investment gain of 5.8% when investing in the constructed optimal portfolio. The portfolio's risk is 4%, meaning that investors face a potential loss of 4% if they choose to invest in this optimal portfolio.

3. The performance measurement of the optimal portfolio yields a Sharpe Index value of 1.348761, which indicates strong portfolio performance. The optimal portfolio can provide benefits to investors because its expected return exceeds the risk-free rate.

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